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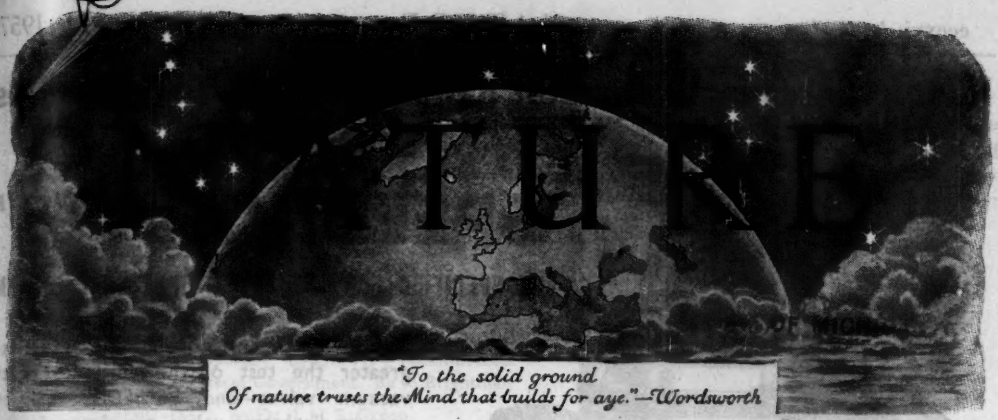

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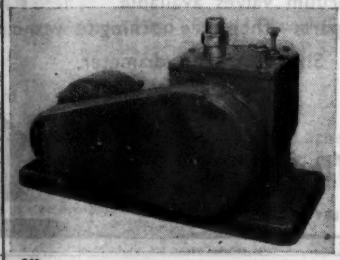

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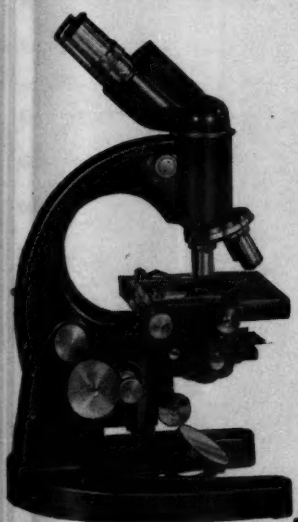

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INFORMATION SERVICES IN THE MODERN WORLD

THE White Paper on Overseas Information Services* which has resulted from Dr. Charles Hill's re-examination of those services should go some way to remove any misgivings which have been aroused by the Prime Minister's statement last January, particularly in view of the delay of the Government in taking action on the recommendations of the Drogheda Committee. Dr. Hill's review has not been published, but the recommendations set forth in the White Paper largely follow those of the Drogheda Report, and when effect has been given to the decisions now taken, the estimated cost of the information services will be about £15 million a year, an increase of some £2 million a year. In addition, capital expenditure is envisaged of the order of up to £5·5 million, or slightly more than the figure which Lord Gosforth, speaking for the Government in the House of Lords on February 6, claimed it would cost to implement the recommendations of the Drogheda Committee.

This expansion, it is now admitted, is necessary to maintain British overseas information services at a level consistent with our world-wide responsibilities, and to ensure the necessary reinforcement of our national policies and our associations in the defence of the free world. This expansion, however, is concerned essentially with the structure of those services, and the White Paper also admits that more needs to be done to ensure that the quality of those services is high, and that problems of staffing and training remain to be examined. Moreover, the official service is only a part of the whole, and more opportunity and encouragement should be provided for people and organizations outside government to assist in developing the full impact of Britain's influence overseas. The necessary administrative arrangements, ministerial and official, to deal with these problems on a regular basis and continuously to co-ordinate the overseas information services have already been made, and there is no intention to establish a Ministry of Information, nor will there be any encroachment on the responsibility of individual Ministers for the work of their information staffs.

This realistic decision to spend more money on what is to-day an essential instrument of policy is welcome also for the clear evidence it gives that the Government recognizes that information services are one of the means by which policy is promoted and opinion influenced, and that their effectiveness depends not only on their size and cost but also on their use of modern techniques. The costs of those techniques are steadily rising, and for that reason alone, although the expansion on which the Government has now decided will cost rather more than that recommended three years ago in the Drogheda Report, its magnitude in terms of effort will be well below that regarded as necessary by the Drogheda Committee; nor indeed has the Government accepted all the curtailments recommended by that Committee. The French, Italian, Danish, Dutch, Norwegian, Swedish and Portuguese services are not all to be abolished, although economies are to be made offering a saving of some £200,000 a year, including the abolition of the last five services.

This decision is for reasons of policy, to which information effort must obviously be geared. The closing of the transmitting stations involved in complete abolition would weaken the transmissions across the Iron Curtain, and might undermine confidence in our continuing interest in Western Europe. Apart from this, however, expansions in the external services of the British Broadcasting Corporation, estimated to add £258,000 to the present annual cost of nearly £5·75 millions, have been approved. In addition, much of the Corporation's equipment needs replacement or modernizing, and the Government has approved in principle a programme of capital replacement, the phasing of which is to be discussed with the Corporation. Furthermore, in affirming that the Corporation enjoys independence of programme content, the White Paper also states that, in the Government's view, the impartiality and objectivity of the British Broadcasting Corporation are national assets of great value, and that the Corporation's independence should be maintained. Independence can be consistent with a close liaison between overseas departments and the Corporation on the basis of mutual confidence and understanding, and it may be concluded that Dr. Hill has done something to promote departmental accord and understanding.

While in many countries sound will remain the main broadcasting medium for the immediate future, the White Paper recognizes that British information services must take full advantage of the opportunities which television offers. While it is too early to define a hard-and-fast policy, the Government has decided on some immediate expansion of television activities. In so far as the various agencies concerned with the promotion of television overseas, including the British Broadcasting Corporation, can secure the export of their air material, they are warmly encouraged to do so. Where they produce for home consumption material which the Foreign Office, the Commonwealth Relations Office, the Colonial Office or the Board of Trade thinks it would be useful to have exhibited overseas, although commercial showing would be unremunerative, the Central Office of Information will be authorized to negotiate for the rights in that material for the area concerned, while the Central Office of Information will substantially extend its activity and expenditure in the development of television films. It proposes to offer about an hour a week of British material to the principal stations in most countries where television operates, other than those behind the Iron Curtain, including a weekly news service for Colonial use; and there will be

* Overseas Information Services. Pp. 8. (Cmnd. 225.) (London: H.M. Stationery Office, 1957.) 6d. net.

more Commonwealth 'televiews' for Australia and Canada and new series of programmes in foreign languages. It will also supply to selected posts overseas libraries of background shots of material about Britain for use in television programmes.

Careful study of the work of the British Council, which, although it has political and commercial effects in the broadest sense, is confined to the educational, scientific, professional and cultural fields, appears at last to have convinced the Government both of the high quality of material which the Council produces, and the value of its work in fostering contacts with influential individuals, particularly in the professional classes, and with students who are likely to be leaders of opinion in their own countries. High importance is now attached to its care of students who come to Britain from the Commonwealth and from foreign countries, and to its furtherance of the teaching of English; and besides certain extensions to the Council's overseas posts, the Government has decided on urgent expansion of the teaching of English, the demand for which already greatly exceeds the supply.

The White Paper points out that the English language is a commodity in great demand all over the world. It is a key to our literature and so to our culture, quite apart from the fact that it has largely replaced French and Latin as an international language. It is thus a valuable export likely to facilitate the export of British advisers and technologists, British technological and university education and British plant and equipment. The advantages to be gained from increasing the number of potential customers who can read technical and trade publicity material written in English are obvious.

The main factors deterring United Kingdom teachers of English from taking posts overseas, other than in the Colonies, are lack of assurance about adequate salary and security of contract and uncertainty of re-employment in Britain on return. These difficulties can sometimes be met by extending the practice of giving a teacher going abroad a contract with the British Council, which would accept responsibility for filling the post on behalf of an overseas authority; but it may also at times be necessary for the British Council to give financial assistance if the overseas post is to be attractive to teachers from Britain, and accordingly the Ministry of Education and the Scottish Office will establish an agency to assist both the Colonial Office and the British Council in recruiting teachers for overseas posts, including teachers of subjects other than the English language. This agency will also assist reinstatement on a teacher's return. Up to one hundred scholarships will be established to enable key students from overseas to come to Britain for training in teaching the English language, and the British Broadcasting Corporation is being requested both to expand its "English by Radio" programmes and to consider including more such material in other programmes.

Other forms of expansion in the British Council's central services on which the Government has decided include, besides increases of staff, an improved pension scheme, the extension of the Council's programme for the care of visitors, especially from the Commonwealth and the Middle East, and increased grants for the inter-university exchange scheme and student welfare services, and more British Council books and periodicals for libraries. Here we touch on a factor to which neither the White Paper nor the Drogheda Report appears to attach sufficient weight. The latter accepted the view that libraries of English books are the essential core of all British Council centres abroad, and noted the observation of the Foreign Office that in various countries the import of British books is impeded by exchange restrictions. It also recognized the importance of the Press as a vehicle of information; but it failed to emphasize the great part which periodicals and books have to play in making known the British way of life and the British contribution to human thought and achievement.

The Foreign Office suggested that for countries where exchange difficulties arise, a scheme such as the British Book Export Scheme, which worked well in the years immediately following 1945, should be adopted. Under this scheme the British Government paid the British exporter, while the foreign importer made payment in his own currency, either to the British diplomatic mission or into a blocked account from which periodic releases were made, or both. Something of this nature would still appear to be required, for it is principally in such countries as Turkey, Indonesia, South America, India and Pakistan, where Dr. Hill's survey has indicated that an extension of information about Britain is needed, that sterling is short, and libraries, universities and individuals are unable to purchase the British books and periodicals they need and desire. Moreover, the position is made worse by the subsidies by which the United States ensures that American text-books and periodicals are at the disposal of a world hungry for information conveyed in the English language.

As a concrete example Turkey may be cited; the import of British books and periodicals in Turkey was stopped in 1955 because of a currency crisis. To-day they appear to be scarcely obtainable in Turkish bookshops, whereas French and German books are fairly easily procurable and American publications occupy the position formerly held by British publications. This matter is, of course, rather outside the range of Dr. Hill's recent inquiry, but it bears too closely on the effective functioning of information work for complacency at the Board of Trade about the relative positions of exporters of British books and periodicals and their American counterparts, which has recently been the subject of strong complaints. Much of the benefit of the expansion of the teaching of English overseas will be lost if British books and periodicals are not available for new potential readers.

Nor is currency the sole difficulty which handicaps the export of British books and periodicals. Recent steep increases in postage and mounting costs of

paper and printing have jeopardized the existence of various learned periodicals in Britain. Further increases in the price of those that survive are almost inevitable, and this will make it still more difficult for the foreign reader to buy British scientific and technical periodicals and books—literature which has in the past made no small contribution to Britain's prestige in the world.

The difficulties under which the distribution of British scientific and technical literature in the world labours to-day are too much the direct or indirect result of official policy for a Government to be indifferent; especially when that Government has affirmed so unequivocally as in Dr. Hill's White Paper its belief in the value of overseas information services, both official or unofficial. In large measure, the difficulties can only be removed by Government action, though it should not be forgotten that information services can only extend Britain's influence and prestige in the world if there is a worthy way of life and great achievements to project. There should be no complacency in that respect, as the events of this year have shown. Nevertheless, the learned societies and professional associations might well consider some fresh approach to the Government, possibly through the medium of the Parliamentary and Scientific Committee, on this broad issue of the future of British scientific and technical periodicals and books, and how they can once again be enabled to make their full and proper contribution to British prestige in the world.

There is much which is welcome in the White Paper on Overseas Information Services, particularly the recognition of the opportunities which television affords and of the importance both of continuity and of other and independent means of influencing public opinion; nevertheless, vigilance and much effort on the part of independent bodies will still be required. Even now the best assurance that continuity will be maintained in the official services probably lies in an all-party approach to the whole question, particularly if the impending changes in the sound programmes of the British Broadcasting Corporation are not to impair our resources. Moreover, such an approach would make its own contribution to ensuring that there is a worthy picture to present. Nor can it be too often emphasized that it is only by the assiduous efforts of independent bodies that the most effective use can be made even of the official information services. By and large, it is through the vigilance of such bodies that mistakes are rectified and obstacles to the presentation of British achievements and ideas are removed, whether in broadcasting, in the Press or in any other ways. It is only when such independent bodies take their full share of the presentation of the life and work of Britain that the full effect of the British Broadcasting Corporation's high reputation for objective and honest reporting will be felt. What matters is not that there should be one voice of Britain, but that the many voices and means which set forth British ideas and policy and achievement should be inspired by a like ideal, and tell their story—forcefully if need be—but objectively and clearly.

RELIGION AND HUMANISM

Religion without Revelation

By Dr. Julian Huxley. New and revised edition. Pp. xii + 252. (London: Max Parrish and Co., Ltd., 1957.) 21*s*. net.

"WHAT the world needs is an essentially religious idea system" (including "beliefs, attitudes and general assumptions as well as intellectual ideas"), but it must be an idea-system which has come to terms with the methods and results of the sciences of Nature and man. That means that it must be a religion without revelation and without belief in a personal God. Such is the challenging and thought-provoking thesis propounded by Dr. Huxley in this work, which was first published nearly thirty years ago and now appears in a new edition with alterations and additions but with its main conclusions still the same.

Dr. Huxley writes as a distinguished scientist who has been profoundly interested in and influenced by religion from his early years. He has an extensive knowledge of the relevant literature. His evidence is drawn from personal experience, as well as from anthropology, comparative religion and religious psychology, and he writes with complete candour. Whether or not they agree with his assumptions, his arguments and his conclusions, scientists and theologians and reflective members of the general public who would like to be able to give a reason for the faith that is in them should find his treatment stimulating and suggestive. Dr. Huxley's objection to revelation is that "in any straightforward sense of the term" it is inconsistent with the method of science, according to which "truth is not revealed once for all, but has to be progressively discovered". Belief in an infallible God-given revelation, he contends, dispenses men from further inquiry, leads to fanaticism and is a bar to progress. Moreover, he thinks, there is no God, no personal or supra-personal supernatural agent from whom the revelation could come. Science has been gradually showing that the phenomena which were once regarded as due to the activities of supernatural agents are in fact the results of the operation of natural causes. The belief in the existence of such agents "is best thought of as in origin a natural and inevitable error of primitive thinking... a mistaken projection of personality into the non-personal", which "it will soon be as impossible for an intelligent educated man or woman to believe in as it is now to believe that the earth is flat or... that death is always due to witchcraft".

That is the negative aspect of his thesis. The positive aspect is that religion is important and necessary, as necessary as science and as firmly based on experience. If we say that religion is an experience, and theology a theoretical interpretation of that experience, we might state Dr. Huxley's view as being that there is no conflict between science and religion, but that there is a conflict between science and certain theologies. Those theologies are hypotheses to explain the facts which give rise to religious experience, but the progress of science has shown them to be erroneous. The facts and experiences themselves, however, are real and important. Dr. Huxley's account of them, however, is neither clear nor consistent. Certain situations or occurrences which have or are believed to have a bearing on human destiny give rise to what he sometimes calls

'a feeling', sometimes 'a feeling and belief', sometimes 'a sense', and sometimes 'an apprehension' of sacredness or holiness or sanctity. This variety of expressions betrays a wavering between two inconsistent views, both of which would seem to be necessary to his thesis. According to one, the main and certainly the original element in religion is feeling or emotion, and this feeling tends to find expression in ritual practices, and gives rise to certain beliefs. According to the other, the experience is from the first cognitive, the awareness or apprehension of 'a sacred reality' which gives rise to a feeling of reverence or awe. But what Dr. Huxley wants specially to emphasize is that the situations, the feelings, the beliefs and the actions concerned are all natural, all situations or events either in external Nature or in the history of the human mind. There is, in fact, no supernatural event or agent, no higher being than man, no source for his ideals and values except his own nature.

The negative aspect of Dr. Huxley's thesis is more definite and precise, and the case in support of it is more consistently and forcefully argued. The positive aspect, to which he would seem to attach at least equal importance, is less clearly and consistently developed. On this side what we seem to find is less the systematic development of an argument than a series of essays on specific topics, written at different times and for different purposes, and united only by their opposition to revelation and the idea of God. The account of the theology or world-view which he would substitute for them seems to vary from context to context. For example, when Dr. Huxley is arguing that his view retains all that is essential to religion, he emphasizes the mysterious, awe-inspiring, 'sacred reality' which we find in religious experience; but when he is expounding evolutionary humanism, 'the religion of the future', the emphasis is on human ideals and values naturalistically conceived, and on man as the creator of his own values, the master of his destiny and the director of evolution. No reference is made to and no room seems to be left for a sense of a sacred reality which alone would seem to provide an object worthy of worship. Accordingly, though there is much in the work that is true and wise and penetrating, its main argument seems to me neither convincing nor consistent; and if its main conclusions were established, I think it would be more in keeping with linguistic usage to call the result an ethical system than a religion.

A. Macbeath

THEORY AND TECHNOLOGY OF SEMICONDUCTORS

Semiconductors

Their Theory and Practice. By Prof. G. Goudet and C. Meuleau. (Translated by G. King.) Pp. xviii + 316. (London: Macdonald and Evans, Ltd., 1957.) 105*s*.

Rectifying Semi-Conductor Contacts

By H. K. Henisch. (The International Series of Monographs on Physics.) Pp. xii + 372. (Oxford: Clarendon Press; London: Oxford University Press, 1957.) 70*s*. net.

Prof. G. Goudet and C. Meuleau have attempted to give a comprehensive summary of the present state of semiconductor theory and technology. This is an enormous task in a single volume, and it is inevitable that certain aspects of the subject cannot be treated as fully as one would wish. Here the emphasis has been placed more on the basic theoretical ideas than on the experimental aspect of semiconductors, with the result that in some of the later parts of the book dealing with experimental work, the information given is incomplete, and in some cases rather misleading. For example, in discussing measurements of minority carrier life-time, the authors spend considerable space on the Valdes method of measurement, when in fact the photoconductive decay method, which is mentioned only briefly, is nowadays generally preferred, especially in the case of silicon.

The book is divided into three parts. In Part 1, the development of semiconductor theory is traced on the wave mechanical basis of de Broglie and Schrödinger; some discussion is also given of the statistical mechanics of particle behaviour leading to the Fermi–Dirac statistics, and the band theory of electronic energy distribution in solids is outlined. The authors then proceed to examine the mechanism of charge movement in semiconductors, treating in detail the effects of electric and magnetic fields on the movement of charge carriers and introducing such important parameters as mobility, diffusion constant, and minority carrier life-time.

In Part 2, which is concerned with the technology of semiconductors, the influence of crystalline perfection on the electrical properties of the more important materials is considered. In much of this section, the information presented is too brief to be of real value to the worker in the field of semiconductors, this being particularly true of Chapters 6 and 7; for example, in Chapter 7 only a brief outline of the methods of crystal preparation is given, and the bibliography appears rather limited for a book of this type.

Part 3 concerns the principal applications of semiconductors and covers in some detail crystal diodes and rectifiers, transistors and photocells. Here the aim has been to compare the various types of device rather than to give a detailed description of each. Considerable space is devoted to point-contact and grown-junction transistors, and it may be that more emphasis should have been placed on the alloyed- and diffused-junction types in view of the developments of the past few years.

On the whole, this book should be a good theoretical reference work for the worker engaged in semiconductor activities, and provide also a useful introduction to semiconductor technology for those entering this field.

Mr. G. King, who is responsible for the translation from the original French, has produced a most readable text.

Dr. H. K. Henisch provides a survey of the present state of knowledge of contact phenomena and rectification at semiconductor surfaces. This book is a welcome addition to the literature on semiconductors; in the present state of semiconductor development, it is probably true to say that the phenomena occurring at semiconductor surfaces are the least understood part of the subject, and in this volume Dr. Henisch has collected a basic fund of knowledge upon which any investigator of surface and contact phenomena may usefully draw.

The book begins with an introductory section devoted to the theory of electrons in solids, which is

followed by a chapter describing the bulk properties of germanium, silicon, lead sulphide, selenium, and cuprous oxide. Practical forms of metal–semiconductor rectifiers, of both the large-area and point-contact types, which use these materials, are discussed in detail, and three chapters are then devoted to an examination of the various theories of rectifying contacts which have been proposed.

The final chapters contain a most useful description of important experiments on point-contact and area-contacts between metals and semiconductors, and an interpretation of the experimental results is given in each case. Dr. Henisch is particularly well qualified to describe this work, since important contributions to it were made by him and his co-workers in the University of Reading.

Although in the past few years the emphasis has been largely transferred from surface-rectifying barriers to *p–n* junctions, the problems of surface physics associated with such junctions are very closely allied to those of the surface-rectifying barrier, and for this reason, the material contained in this book will be of use to all those concerned with the theory and applications of semiconductors.

A. A. SHEPHERD

TECHNIQUE IN ORGANIC CHEMISTRY

Technique of Organic Chemistry

Edited by Arnold Weissberger. Vol. 3. Second completely revised and augmented edition. Part 1: Separation and Purification. Pp. xi+873. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 17.50 dollars.

A Guide to Qualitative Organic Chemical Analysis

By Prof. R. P. Linstead and Dr. B. C. L. Weedon. Pp. xi+169. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1956.) 21*s*.

Semimicro Qualitative Organic Analysis

The Systematic Identification of Organic Compounds. By Prof. Nicholas D. Cheronis and Prof. John B. Entrikin. Second edition. Pp. xiv+774. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1957.) 9 dollars.

Organic Analysis

Vol. 3. Editorial Board: John Mitchell, Jr.; I. M. Kolthoff; E. S. Proskauer; and A. Weissberger. Pp. viii+546. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 11.50 dollars.

WHEN Faraday condensed his knowledge and experience of laboratory practice into one volume of about six hundred pages, he could not have foreseen the developments in practical chemistry that would eventually require a shelf full of books to describe the technique necessary for any one of its specialized branches. Yet the application of more and more new methods to the elucidation of problems of chemical structure or of reaction mechanism makes it essential for the practising chemist to have information on these matters in an accessible and collected form. For the organic chemist this has been done in a series of nine volumes under the general title "Technique of Organic Chemistry" edited by A. Weissberger. The worth of the collection can be measured by the tattered condition of library copies and by the fact that new editions of these volumes are being issued. One of these, Vol. 3, is split into two parts, of which the first is a subject of this review. It deals with the separation and purification of organic compounds by crystallization, filtration, extraction and diffusion methods. There are also chapters on solvent removal and centrifuging. These accounts are up to date, authoritative and plentifully supplied with references to original papers and other sources of information. Yet when they deal with general descriptions of techniques which have been practised since the beginning of chemistry they give the impression of being somewhat too diffuse. There is a stimulating section of the chapter on diffusion methods, which discusses the application of thermal diffusion for the separation of liquid mixtures. The technique of this method is still being developed and it offers the prospect of a useful means of separating some pairs of liquids of approximately the same boiling point.

In spite of the increasing number of new techniques which are being used by organic chemists, instruction in the art of qualitative organic chemistry is still an essential part of the training of a chemist. It provides the student with the opportunity of linking deduction to observation and of acquiring at first hand some experience of the exercise of independent judgment and the selection of suitable methods for testing his conclusions. Qualitative organic analysis is indeed essential to any complete course in organic chemistry; its value to the student is determined almost entirely by the way the subject is presented. It is of more than usual interest to all who are charged with the instruction of students in practical organic chemistry to have available, in book form, the system of instruction which has been developed in the Chemistry Department of the Imperial College of Science and Technology. In this book, "A Guide to Qualitative Organic Chemical Analysis", by Drs. Linstead and Weedon, is outlined a scheme for the identification of single substances based on the reactions of the functional groups and their characterization by the preparation of suitable derivatives. There are twenty-seven tables giving melting and boiling points of the commoner members of typical groups of organic compounds and their derivatives. Clear directions are given for the preparation of characteristic derivatives of each group. There is also a short chapter on the examination of mixtures. The book is written for students taking an honours degree in chemistry; it also provides a sound and satisfactory basis for more advanced work. It can be recommended to the attention of all who teach practical organic chemistry and it should be in the possession of all students reading for a degree in chemistry.

The first edition of "Semimicro Qualitative Organic Analysis" by Profs. Cheronis and Entrikin was published in 1947 as a relatively slender volume of about five hundred pages; this new edition has been expanded by about 250 pages by adding to the existing material and by introducing new sections. The subject-matter has also undergone some reorganization. The emphasis of the book is on manipulation of semimicro quantities and its chief merit is in the descriptions it gives of the preparation of

derivatives for the characterization of functional groups. There are also very complete tables of physical constants to aid the identification of organic compounds as well as schemes for the recognition of typical groups. These sections are preceded by an account, about 150 pages in length, of techniques for handling small quantities of material. Operations such as crystallization, distillation, extraction and chromatographic separation are described in considerable detail and there are some useful descriptions and diagrams of suitable apparatus. A small section on infra-red absorption spectra is also included.

From the authors' introduction, it appears that the book is designed to be used not only by practising organic chemists but also by students who are starting practical organic chemistry. In this, it is possible that the authors have gone too far in their enthusiasm, for it is extremely doubtful if any beginner can efficiently acquire a competent technique in the handling of semimicro amounts, without having previously undergone the discipline of well-founded instruction in the art of crystallizing, distilling and purifying larger amounts.

The intention of the editors of the series of volumes under the title of "Organic Analysis" is stated to be to present an up-to-date picture of techniques for the estimation of organic compounds, and reliable and critical information about new methods and procedures. This is a high standard to maintain over a series of volumes, but it is evident that Vol. 3 in no way falls below the standard set by the previous volumes. The general content of Vol. 3 may be gauged from the titles of the reviews; determinations of organic acids, of acid anhydrides, of amines and amides, and of olefinic unsaturation. The volume is completed by a review of the applications of analytical mass spectrometry to organic analysis, and by one on the analytical characterization and determination of some commercially important classes of synthetic organic coating resins. These reviews are of special interest to the analyst, but can be read and used with profit by organic chemists with more general interests. In particular there is a satisfying and critical survey of methods of estimating unsaturated linkages; it covers not only methods based on saturation of the double bond, but also those depending on what the authors call 'instrumental methods', among which are infra-red and ultra-violet absorption, and chromatographic methods.

W. J. Hickinbottom

SCIENCE AND THE UNITED STATES GOVERNMENT

Science in the Federal Government

A History of Policies and Activities to 1940. By A. Hunter Dupree. Pp. xi+460. (Cambridge, Mass.: The Belknap Press of Harvard University Press, 1957.) 7.50 dollars.

In this book Mr. A. H. Dupree gives a readable and scholarly account of the relations between the Government of the United States and scientific work during the first hundred and fifty years of the Federal Union. It is a picture of the place which science has taken in the growth of the American nation and, concerned rather with the organization of both science and government and the formulation of policy than with the advance of science itself or with technical invention, it makes an admirable complement to Prof. J. W. Oliver's recent "History of American Technology" (see *Nature*, 179, 338; 1957). The development of the Smithsonian Institution, the American Philosophical Society in Philadelphia, the National Academy of Sciences, and the later Carnegie Institution of Washington, the Rockefeller Foundation as well as the Tennessee Valley Authority and the Office of Scientific Research and Development and other bodies created to meet the needs of the country in the Second World War are all seen to fall into their natural places. Mr. Dupree's leisurely narrative provides a background which explains points that sometimes puzzle those overseas regarding the antecedents of that series of reports, following on "Research: A National Resource" and continuing with "Science: the Endless Frontier" and "Science and Public Policy", which emphasized the profound concern of the United States Government to-day with the function and use of science.

The book is, however, something much more than a complement to these reports or to the recent description of the present organization of the Federal Government for scientific activities which the National Science Foundation has published. Mr. Dupree rarely discusses developments, such as Mr. D. K. Price discusses in "Government and Science". He is content to record the facts in such guise that the situation comes alive, and for this reason his book will be of wide interest outside the United States. Essays which display so penetratingly the reactions between science and government are all too rare, and although Mr. Dupree's canvas is ample, this account of the American scene is calculated to assist the understanding of the British scene also, and not least to convey more than a hint to the British scientist on how to handle such relations.

There is indeed nothing that really approaches this book in covering the relations between science and government in Britain over the same period. Prof. Armytage gave some sidelights in "Civic Universities", but no book on the Civil service has covered this aspect, and Dr. D. L. S. Cardwell's recent study of the organization of science in England also passes it over, though it was noticed in some of the studies stimulated by the Perkin centenary last year. It will surprise many to learn from Mr. Dupree's book how long the history of science in America is, how deep the roots of science go both into science and government, and from what early days the United States Government has been concerned to foster science. Well produced as well as written, with ample bibliographical references, and a chronology as well as an adequate index, it will interest all those concerned with the relations between science and government. For a book which illumines those complex relations and their dangers, there are two curious omissions. There is no mention of either the American Association for the Advancement of Science, although *Science* is freely quoted, nor of de Tocqueville, though de Tocqueville's remarks on the influences of democracy upon science in America, and his observations that the democratic principle does not induce men to cultivate science for its own sake and on the neglect of theoretical and abstract knowledge in the United States, are highly relevant to Mr. Dupree's account and endorse his concluding argument.

R. Brightman

The Encyclopedia of Chemistry

Edited by Prof. George L. Clark and Gessner G. Hawley. Pp. xvi+1037. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1957.) 156*s*. net.

THIS useful volume contains a very large amount of up-to-date material which it would be difficult to find elsewhere in such moderate compass. The articles are written by specialists and are, in general, very good. A wide field is covered and industrial applications receive careful treatment. The volume should be available in reference libraries. Since the book will no doubt go through many editions, it will not be out of place to refer briefly to what the reviewer thinks shortcomings. The index is most inadequate. The editors say that they kept the contributions strictly within the compass planned, and in some cases they have unduly cut down excellent articles and given far more space to poor ones than they deserved. In the accounts of persons and institutions the choice seems to be haphazard; although quite minor American institutions have long sections giving the names of present staff in full, the National Physical Laboratory and other famous foundations are not mentioned. Ostwald is mentioned but not Nernst, Herty but not Harden. Rutherford is still Sir Ernest and Aston is missing. In general, the editors do not seem to have been equal to their task. The spelling is sometimes weak; whether 'van der Waal', for example, is the responsibility of the author or is an editorial correction I do not know, but it should not appear.

J. R. PARTINGTON

Elementary Practical Organic Chemistry

By Dr. Arthur I. Vogel. Part 1: Small Scale Preparations. Pp. xv+348+xiv. (London and New York: Longmans, Green and Co., Ltd., 1957.) 21*s*.

THE author has planned a three-volume work of which this is the first part. The book opens with forty pages of theory, followed by a long chapter on experimental technique. Besides dealing with customary purification processes, it contains an account of special small-scale apparatus—mostly modifications of familiar types used in macro-work—which the author has tried out and recommends. By standardizing the size of necks of flasks and the diameter of side-arms he has shortened the time required to set up an experiment. These devices and modifications have been carried out in co-operation with a large manufacturing firm, so that the standard apparatus may be obtained through laboratory suppliers. Many teachers will welcome the information in this chapter, for the text is punctuated with helpful notes on theory, comments on reagents and processes, laboratory devices and safety precautions. Chapters 3, 4 and 5 give practical directions for the preparation severally of a selection of aliphatic, aromatic and miscellaneous compounds. Although called 'elementary' these preparations are mostly of the class required by university students. They include one requiring the use of sodium borohydride and one reduction with lithium aluminium hydride. The publishers claim "that the requirements of all examinations involving a knowledge of practical organic preparations are fully met" and that the volume should be suitable for grammar schools, technical colleges and universities. However, it must be pointed out that "elementary organic preparations", so far as British grammar schools are concerned, refer to such compounds as alcohol, acetone, acetic acid, chloroform, ether, ethylene, ethyl acetate and formic acid. The preparation of not one of these is given. Moreover, we are not told whether their omission implies that their preparation on a small scale is not expedient. Dr. A. I. Vogel believes that many of the preparations are new, and he states that all have been checked over in his laboratory. The advice on apparatus and technique, and the experience gone to the making of the book will commend it to teachers. Where it is not used as a class text it should be on the laboratory shelf.

G. FOWLES

Russian–English Glossary of Nuclear Physics and Engineering

Pp. ii+195. (New York: Consultants Bureau, Inc., 1957.) 10 dollars.

THIS excellent compilation gives idiomatic English equivalents of more than 10,000 Russian words and phrases. Its range goes beyond nuclear physics, nuclear engineering and atomic energy to include almost every technical word that might be encountered in Russian literature on those subjects. Errors are very few, and omissions are hard to find. There are some misprints in both Russian and English, but none is likely to cause serious difficulty. The main contribution to the list has been obtained by inverting various English–Russian dictionaries of similar scope, sometimes a little ineptly; it is evident in places that the Russian version is an explanatory translation of the English rather than an expression that might be used in scientific writing.

No grammatical information is included—not even an indication of parts of speech—and common words are not given, so that the glossary is of limited use to anyone not already familiar with Russian. The last page gives the Russian transliterations of various place names connected with work on atomic energy.

The binding is somewhat flimsy for a reference book. The glossary is described as the first of a series, from the same publishers, dealing with various branches of physics and ultimately to be included in "a comprehensive and authoritative dictionary of contemporary Russian terminology in all fields of modern physics". Such a work will be exceedingly valuable if the standard of this first instalment is typical.

J. B. SYKES

The United Kingdom Contribution to the International Geophysical Year, 1957–58

Pp. 72. (London: The Royal Society, 1957.) 10*s*.

THIS publication provides more than its title would lead one to expect. It contains a short, clear account of each subject to be studied during the International Geophysical Year, covering the observations to be made in each and the problems to be attacked. Each subject is linked with the others. Full details are given of the selection of the special periods, the observations to be made during them, and a calendar of those fixed in advance. Thus far the publication is international in scope, but finally we have also a record of the British share of the work with lists of those British scientists who have planned it. It is a book both to read and keep for reference on details. It is essential for all, professional scientists or laymen, who take a serious interest in the Geophysical Year.

G. A. BULL

JOACHIM JUNG (1587-1657)

By Dr. J. H. S. GREEN

THE three hundredth anniversary of the death of Joachim Jung occurs on September 23. The importance in the history of science of his influence and work is not small, and is worthy of notice and summary on this occasion. Jung (Junge, Jungius) was born at Lübeck on October 27, 1587. According to Poggendorff[1] he was for five years from 1609 professor of mathematics at the University of Giessen, but during this early period he also studied pharmacy at Rostock[2]. However, he then moved to Pisa and Padua, graduating in medicine from the latter University in 1618. In view of Jung's later ideas and work this period spent in Italy must be considered of great importance. Singer has written of "that true nurse of the sciences, free Padua", pointing out "that there, alone among the universities, religious tests were so applied as to be in effect, nugatory"[3]. At Padua, some fifteen years after Harvey, Jung came under the influence of the great Fabricius (1537–1619) as continued by his pupil Giulo Casserio (1561–1616) and by Adrian Spigelius (1578–1625). Similarly, at Pisa he was influenced by the tradition of Andrea Cesalpini (1519–1603). Returning to Germany, Jung held a number of appointments: at Rostock and Lübeck as professor of mathematics, with a break of six months at Helmstadt as professor of medicine, and finally at Hamburg where he ultimately became in 1628 rector of the Johannaeum, or high school, until his death in 1657.

Jung's educational activities continued, therefore, for the last thirty years or more of his life. But even as a young man he had been one of a group of educational reformers associated with Ratke (1571–1635). Of particular significance among their activities was the emphasis on the vernacular, for in this respect Germany was especially backward at this time. Jung wrote: ". . . all arts and sciences, as, for example, the art of government, knowledge of weights and measures, of medicine, astronomy, architecture, fortification, can much more easily, comfortably, correctly, perfectly and explicitly be taught and promulgated in German than in Greek, Latin or Arabic"[2]. Notable here is the emphasis on technology. With his versatile activities and enthusiastic advocacy of experimental inquiry, it is not surprising that Jung became involved in controversies with the local priests. He was accused of heresy and threatened with excommunication, though this did not occur. Goethe wrote: "If people had followed the advice of Jungius as to methods of study, the world would have reached, a hundred years earlier, that point at which it is to-day".

The best-known work of Jung is probably that on botany; but he played an important part in two of the most important features of seventeenth-century science—the formation of scientific academies, and the revival of atomism. The Societas Ereunetica was founded by him at Rostock in 1622[2]. Apart from a number of informal gatherings of men interested in science, such as that which gathered around della Porta (1538–1615) in the 1560's, the Societas Ereunetica was preceded only by the Accademia dei Lincei (1600–30), with which Galileo was closely associated in Rome. Jung's society was founded two years before the publication of Bacon's "New Atlantis" but similar influences were at work in the German society, as evidence its motto: *Per inductionem et experimentum omnia*. Jung, like Comenius, was probably influenced by Valentin Andrae's "Reipublicae Christianapolitanae descripto" (1619), which had put forward the idea of an academy similar to that of Bacon. (Andrae has, indeed, been referred to as the Bacon of Germany.) The Societas Ereunetica lasted for no more than two years, and its direct influence was probably small. Though its aim was to carry out experiments, it produced no body of experimental work such as the "Saggi" of the Accademia del Cimento. Its historical significance arises from its early date and from Jung's association with it.

Jung's contributions to the revival of the atomic theory[4] are often overshadowed by those of Gassendi, Sennert, Basso and others; but they are significant and were of contemporary importance. His ideas seem to have been similar to those of Sennert (1572–1637); an account of views appeared in 1619 and more fully in 1636. Jung's views were first written down about 1630 in his "Doxoscopiae Physicae Minores" (published in Hamburg in 1662), but were first published in 1642 in two 'disputations': "Disputationum de principiis corporum naturalium" (March 30, April 2, Hamburg, 1642). These were really academic exercises of the Hamburg gymnasium.

Both Sennert and Jung emphasized that in chemical changes the individuality of the atoms is retained—Jung citing the example of the replacement of copper by iron in a copper sulphate solution. In regarding this as an exchange of atoms and not as a transmutation, Jung was breaking away from the scholastic philosophy, and reverting to the corpuscular theory[5]. Sennert postulated atoms corresponding to each of the four Aristotelian elements, together with elements of the second order (*prima mixa*) formed by a combination of these. Jung conceived his atoms as being of irregular shape, angular and sharp, and in his writings have been seen the ideas of isomerism and stereochemistry.

These views, and those of Gassendi, were known to Boyle, who refers to Sennert in "The Sceptical Chymist" (1661). Sarton has described Jung's (1642) account as "very abstract and forbidding"[6] and states that Boyle is less likely to have known of it than that of Gassendi. It is known, however, that Boyle received a "rude draught of Dr. Jungius' Protonoetical Philosophy" in a letter from Samuel Hartlib in May 1654, though he knew of Gassendi's work earlier than this.

In his botanical work Jung was particularly influenced by the Italian tradition. The botanical garden at Padua, the first to be attached to a university, was

laid out in 1545; that at Pisa, provided at the expense of the Medicis, followed two years later. Of great importance was the work of Andrea Cesalpini at Padua, who gave more detailed attention than previously to the morphology of flowers, particularly the organs of pollination, and of Caspar Bauhin (1550–1624), a student of Fabricius, who introduced the binomial system of class names. Cesalpini was strictly Aristotelian in his ideas of the nature of plants, and he retained the traditional four categories of plants—trees, shrubs, half-shrubs and herbs—which he subdivided on the basis of the fruit. Jung took this further in his important developments in classification and morphology; but his considerations were free of Aristotelian speculation.

In describing the various parts of the plant, Jung gave clear definitions, which, although abstract, were the basis of subsequent comparative morphology. Thus, "a leaf is that which stretches out from its place of attachment in height and length so that the surfaces of the third dimension are dissimilar to one another; it is the leaf's inner surface that is differentiated from the outside". On this basis, and the fact that they fell off in autumn, he distinguished compound leaves from the branches with which they were frequently confused. Again, the stem was defined as the upper part of the plant, stretching upwards such that the back, front and sides were indistinguishable, and Jung described the changes of the stem leaves with increasing distance from the ground.

He was unaware of the sexuality of flowers, but described fully the forms of flowers, and on this basis distinguished between the Compositae, Labiatae and Leguminosae families. He rejected the classification into trees, shrubs and herbs, as well as others based on colour, scent, medicinal uses, and so on. Much of his terminology of the parts of plants remains in use to this day, for example, the terms used to distinguish different types of inflorescence. His contributions to morphology and nomenclature were almost the first developments since the time of Theophrastus (372–287 B.C.), and his "Isagoge Phytoscopica" (Handbook of Botanical Study), which was published in Hamburg in 1678, has been referred to as "the most philosophic and scientific treatise on plants that had appeared since the time of Aristotle", and "the foundation upon which the whole superstructure of plant morphology and descriptive botany has been erected"[7].

John Ray (1627–1705) obtained through Hartlib and John Worthington a manuscript of part of this work before 1660 and many of Jung's definitions were incorporated in his "Index Plantarum Agri Cantabrigiensis" (1660) and in later works in which he also acknowledged his debt to Jung and to Cesalpini. Ray's description of the flower is based on the same source. However, Ray retained the traditional divisions on the grounds of expediency, though he agreed that they were popular rather than accurate or scientific. This weakness of Ray's work persisted even after Rivinus (1690) had shown it to be untenable. Indeed, it persisted until the time of Linnæus (1707–78), who in turn learnt of Jung's morphological principles and terminology from Ray. Linnæus acknowledged Jung as his precursor in the construction of rules for the description of flowers, and in his descriptions of plant organs was continuing Jung's work.

It is frequently stated that Jung published nothing in his life-time, possibly because his greatest influence was exerted after his death. However, there appeared three editions of his "Geometria Empiria" (Rostock, 1627; Hamburg, 1642, 1649), as well as his "Disputationum de Stoecheosi geometria" (Hamburg, 1634), "Trias quaestionum physicarum de naturalium corporum materia et forma" (Hamburg, 1637), the two disputations mentioned above and other works.

Jung, like Comenius and Harvey, represents a transition period between Aristotelian scholasticism and modern science, and he typifies an early phase of seventeenth century science. His botanical work exemplifies this: he made valuable and enduring contributions by a combination of scholastic logic and accurate observation.

[1] Poggendorff, J. C., "Biographisch-literarisches Handwörterbuch", 1, 1211 (Leipzig, 1863).
[2] Ornstein, M., "The Rôle of Scientific Societies in the Seventeenth Century", 167 (Chicago, 1938).
[3] Singer, C., "A History of Biology", 119 (Oxford, 1932).
[4] Lasswitz, K., "Geschichte der Atomistick, vom Mittelalter bis Newton", 2, 245 ff. (Leipzig, 1926). Partington, J. R., *Ann. Sci.*, 4, 245 (1939). Walden, P., "Geschichte der Chemie", 37 ff. (Bonn, 1950).
[5] Hooykaas, R., *Chymia*, 2, 65 (1949).
[6] Sarton, G., *Chymia*, 3, 165 (1950).
[7] Oliver, F. W. (Ed.), "Makers of British Botany", 15 (Cambridge, 1913).

CARBON

THIRD BIENNIAL CONFERENCE

THE third biennial Carbon Conference, sponsored by the University of Buffalo, the U.S. National Science Foundation and the U.S. Office of Naval Research, was held in Buffalo during June 17–21. Interest in the chemical physics of carbon has grown with exceptional rapidity during the past few years. Solid carbon has valuable chemical, mechanical, thermal and electrical properties which indicate various technical uses at ordinary and at high temperatures. The use of highly purified graphite in nuclear reactors provides a second reason for greatly intensified basic and applied research[1]. From a more academic point of view, a close relationship between various properties of the aromatic electrons in condensed aromatic molecules and in graphite has been evident[2] since X-ray structures first became available. However, within recent years a variety of new techniques have been exploited in elucidating the structure and behaviour of graphite and of its crystal compounds. X-ray structural studies have been greatly refined, so as to deal with imperfectly graphitized carbons made from various starting materials. It is generally recognized that such carbons can be regarded as polymers that contain small or large regions of fused aromatic rings, more or less perfectly arranged according to the ideal graphite structure. These regions are joined together in various ways, which

can generally be brought nearer the ideal graphite structure by raising the temperature sufficiently so as to expel chemical impurities and reform non-graphitic carbon–carbon bonds. Optical, magnetic and electronic methods of measurement have been pressed into service, and have yielded important new information such as the presence of unpaired electron spins in certain carbons[3]. A wealth of studies on the disruption of graphitic bonds by radiation damage is now being published and forms a new counterpart to earlier lines of investigation on the formation of graphitic bonds by heat treatment. Six papers on radiation damage to graphite were presented at the Conference. There have also been important developments in the mathematical chemistry of aromatic systems, with graphite regarded as the limit of various series of smaller aromatic molecules.

Like the two earlier Carbon Conferences at Buffalo[4], the present Conference was organized by Prof. S. Mrozowski. About three hundred delegates were housed on the campus of the University and were exposed to a very strenuous week of discussions of some eighty papers, a visit to Niagara Falls, and a heat wave. There was no official record of the discussions, which were by common consent stimulating and well sustained, but a booklet of abstracts of the papers has been published by the University of Buffalo. It is planned to embark on publication of the papers presented to the Conference at the beginning of October (probably under the ægis of the University of Buffalo).

Broadly, the Conference was arranged as a succession of papers relating to specific researches on graphite and aromatic molecules. There was also inserted a symposium of eight papers, "From Benzene to Graphite", in which trends in aromatic properties could be surveyed in their broader aspects.

Some twenty-four papers dealt with various aspects of the important subject of 'graphitization', by which is meant the transformation of amorphous carbon or of carbon compounds into structures becoming progressively closer to ideal crystal graphite. Graphitization in some ways resembles other forms of bond rearrangement in polymer formation. However, elimination of foreign atoms is frequently a prerequisite and such atoms can 'block' graphitization in certain cases. New investigations based on some of the more familiar methods of studying the process of 'coking' have now been diversified by detailed measurements of carbon formation during the progressive charring of specific organic molecules, such as dextrose or sucrose, and following the electron spin resonance and infra-red absorption (Brown and Turkevich, 5; Singer, Spry and Smith, 6)*. An interesting chemical variant of partly graphitized carbon, stemming from hexamine and containing considerable proportions of nitrogen, was described by Riley (Barniecki and Riley, 34). Suggestive applications of some of these more novel techniques to coals were described by a number of authors.

About twenty papers presented detailed experimental or theoretical studies of the physical properties of carbon. Mathematical computations of energy-levels in idealized graphite and smaller macromolecules (Corbato, 21; McClure, 22; Haering and Wallace, 23; Pullman, 28; Matson, 29) show very considerable refinements compared with the earliest work in this field. Discussions of the mechanical properties of carbons at high temperatures (72, 73) and of the energy exchange between graphite surfaces and gas molecules (18) are of obvious technical as well as academic interest. Electron microscope and electron diffraction studies on artificial graphites (Tsusuki, 13) show dislocations the comparatively large dimensions of which do not appear to be fully explained. Some theoretical aspects of 'aromatic hole defects' and 'claw defects' in graphite were also discussed (Ubbelohde, 31) in relation to known experimental behaviour. Experimental studies of magnetic properties of partly ordered carbons (Pacault, 32; Adamson and Blayden, 8) have now been carried to a very considerable degree of precision.

There were only nine papers dealing more or less specifically with the chemical reactivity of carbons; this part of the programme could undoubtedly have been extended considerably, though it would have drawn somewhat different participants to the Conference. Interesting chemical techniques of testing for the presence of surface groups by methylation, amide formation, chlorination, and the formation of other surface 'derivatives' were discussed (Boehm, Hoffmann and Clauss, 53; Garten and Weiss, 59). Some striking examples were shown of highly localized promotion of the oxidation of graphite by surface catalysts such as iron, gold or silver (Hennig, 56).

Papers on graphite oxide (Clauss, 37), on 'red carbon' (Schmidt, Boehm and Hoffmann, 46), on the synthesis of diamond by members of the General Electric Co. (Tracy Hall, 35) and on graphite whiskers (Meyer, 14) gave tantalizing glimpses, but only glimpses, of new possibilities in the chemistry of carbon. On the other hand, five papers presented on the crystal compounds of graphite emphasize the growing interest in this field. A whole range of interrelated new compounds has been prepared by Crofts (36), who discussed some of the conditions for their formation. Various properties of graphite/bromine were described by a number of authors, and the salt-like model of potassium/graphite was also discussed (Ubbelohde, 38).

Finally, experimental studies on large aromatic molecules such as violanthrene or anthanthrene may be mentioned. Akamatu and Inokuchi (30) described the semi-conductor properties of a substantial group of molecules of this type, which have interesting analogies with graphite. Semi-conductor properties were likewise reported for semi-quinone types of complexes (Eley and Inokuchi, 2). The photo-conduction in single crystals of naphthalene, anthracene, tetracene, phenanthrene, 1-2-benzanthracene, 1,2,5,6-dibenzanthracene, diphenyl, terphenyl, pyrene and chrysene (Lyons, 1) adds weight to the slightly alarming conclusion that the modern physicist who hopes to deal successfully with the problems of carbon cannot afford to ignore quite recondite aromatic organic chemistry.

* Reference numbers correspond with those in the published booklet Programme and Abstracts of the Third Biennial Carbon Conference, June 17–21, 1957, held at the University of Buffalo, N.Y. (Co-sponsored by the University of Buffalo; The National Science Foundation; and the U.S. Office of Naval Research.) Pp. 34. (Buffalo, N.Y.: The University, 1957.)

[1] cf. Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva (1955).
[2] Ubbelohde, A. R., *Nature*, **132**, 1002 (1933).
[3] Ingram, D. J. E., *et al.*, *Nature*, **174**, 797 (1954); where earlier references are given.
[4] Carbon Proceedings, 1st and 2nd Conferences, in one volume (University of Buffalo, New York).

RECENT DEVELOPMENTS IN CLOUD PHYSICS

THE summer meeting of the Royal Meteorological Society, held in Glasgow during July 3–5, began with a lively and well-attended discussion on cloud physics. The meeting, which was held in the Department of Natural Philosophy, University of Glasgow, with Prof. P. I. Dee in the chair, was delighted to welcome Prof. C. T. R. Wilson, now in his eighty-ninth year.

Dr. B. J. Mason (Imperial College of Science and Technology, London) began by describing the results of some recent experiments, carried out in collaboration with J. Hallett, E. J. Langham and J. Maybank, on the supercooling and nucleation of water and on the growth of ice crystals from the vapour. Observations on the freezing of large numbers of droplets of distilled water, ranging from 10μ to 1 cm. in diameter and suspended at the interface of two immiscible liquids in order to avoid the nucleating effects of solid surfaces, had established proportionality between the logarithm of the droplet volume and its freezing temperature for a constant rate of cooling. Such a relationship appeared to characterize the heterogeneous nucleation of water droplets containing small foreign nuclei, and is probably associated with the fact that the ice-nucleating ability of atmospheric aerosols increases logarithmically with decreasing temperature. Dr. Mason went on to describe very recent experiments which had been successful in purifying water to such an extent that droplets could be regularly supercooled to temperatures ranging from $-41°$ C. for 1-μ droplets to $-33°$ C. for drops 1 mm. in diameter, at which freezing occurred spontaneously without the aid of foreign nuclei. The empirical relationship between droplet volume and nucleation temperature, which differed from that representing heterogeneous nucleation, showed good agreement with theory.

Photographs taken of freezing droplets revealed that, in some cases, solidification was accompanied by rupture of the ice surface and the liberation of a number of small ice splinters. This suggests a mechanism by which the numbers of ice crystals in clouds may be rapidly increased.

In an attempt to discover the nature and origin of atmospheric ice nuclei, tests had been made of the nucleating ability of various types of soil particles and mineral dusts, and had revealed that a number of silicate minerals such as kaolinite, microcline and some of the micas were effective at temperatures greater than $-15°$ C. but that the more common silicates were relatively inactive. However, several types of nucleus became more effective once they had been involved in ice-crystal formation. Thus when ice crystals, formed on various silicate particles initially active only below about $-20°$ C., were allowed to evaporate by warming them to very near 0° C. in a dry atmosphere, they left behind nuclei which were thereafter effective at temperatures as high as $-5°$ C. Dr. Mason suggested that although most of the particles carried up from the ground can initially form ice crystals only at the low temperatures associated with the high cirrus clouds, when the crystals evaporate they may leave behind pre-activated nuclei, which may later seed lower clouds at temperatures only a few degrees below zero. This may explain why the tops of shower clouds sometimes show signs of glaciation at temperatures as high as $-6°$ C., although nuclei active at these temperatures are rarely detected in surface air.

Finally, Dr. Mason used a series of photographs to illustrate the growth of ice crystals on a fine fibre running vertically through the centre of a water-vapour diffusion chamber. Clear-cut changes of crystal habit—from hexagonal plates→needles→hollow prisms→plates→stellar dendrites→plates→prisms—took place along the length of the fibre, over which the temperature varied from 0° C. to $-40°$ C. These closely imitated the changes occurring in natural snow crystals. That the relative growth-rates of the basal and prism faces of ice crystals should change so abruptly and so often is very puzzling, but these experiments had clearly shown that the temperature and not the supersaturation of the environment is primarily responsible. The supersaturation is, however, important in determining the growth-rates of the crystals and the development of dendritic forms.

Recent measurements of condensation nuclei, cloud particles and rain, made from aircraft of the Meteorological Research Flight, Farnborough, were described by Mr. R. J. Murgatroyd (Meteorological Office). Raindrops measured at the surface commonly have diameters of 0·5–5 mm., and occur in concentrations of 0·1–1·0 per litre, whereas condensation nuclei have diameters of 0·01μ or more and concentrations of 10^6–10^7 per litre near cloud base. One of the main problems in cloud physics is to trace how raindrops develop after condensation on these nuclei.

Measurement of the total numbers of condensation nuclei from an aircraft by means of a Nolan–Pollak photo-electric counter indicated that concentrations over the land, particularly near industrial areas, are considerably greater than over the sea. Numbers decrease rapidly with height, the profile of concentration in the vertical being mainly determined by atmospheric stability. Cloud droplets, which were measured by impaction on magnesium oxide or oil-coated slides, are usually 10–30μ in diameter with concentrations of 10^5–10^6 per litre, so that only a fraction of the available condensation nuclei are apparently involved in the production of cloud. The most active will be the larger hygroscopic nuclei, probably of sodium chloride, and Mr. Murgatroyd described how the concentrations and sizes of salt nuclei are determined by collecting them on slides coated with a gelatine impregnated with silver nitrate. These particles are mainly in the range 0·5–10μ in diameter with concentrations of 10^2–10^3 per litre, and their vertical distribution is again controlled by atmospheric stability and the nature of their source. In these concentrations they are likely to be associated with only the largest cloud droplets, and it is these which will probably grow to raindrop size by coalescence.

Precipitation elements (greater than 100μ in diameter) were sampled by exposing a thin aluminium foil from the aircraft, and measuring the

indentations produced by the particles on impact, a technique developed by the Mechanical Engineering Department of the Royal Aircraft Establishment, Farnborough. It has been found that small cumulus clouds, a few thousand feet thick, contain droplets about 100μ in diameter in concentrations of 0·1–1·0 per litre, which is of the same order as the concentration of raindrops at the surface. Examples were also given of the way raindrop sizes vary with height in layer clouds at temperatures above freezing, particles growing to raindrop size by overtaking and amalgamating with smaller droplets falling at slower speeds. The same technique is also being used to examine the development of rainfall by the Bergeron mechanism, which involves the ice-phase. Crystals in cirro stratus cloud rarely exceed 250μ in diameter, but in alto stratus and nimbo stratus snow flakes of 1–2 mm. diameter, increasing in size as they fall, are found. There is some size decrease as they melt at the freezing-level and then further increase during the rain stage below. Conditions in cumulo nimbus clouds are much more complex, liquid water drops often being found at temperatures of −10° C. to −30° C. The particles are larger and greater in number than in frontal clouds. In each case a size spectrum of precipitation elements can now be measured at all levels, and it seems likely that it will soon be possible to obtain reasonably complete cross-sections of particle distributions in frontal systems, and study the way they are developing to produce the rainfall observed at the surface.

The discussion took a new and interesting turn when Dr. T. W. Wormell (Cavendish Laboratory, Cambridge) described the results of recent work on electrification processes associated with precipitation near the ground.

The introduction of conducting particles, cloud particles or precipitation elements, disturbs the normal ionic equilibrium in the atmosphere and the particles may acquire considerable charges. The importance of such processes has been emphasized of late by Ross Gunn. In the presence of an electric field, and of droplets with appreciable fall-velocities, other effects of selective capture are likely to be of greater importance.

Once precipitation has started, the effects of splashing may seriously affect electrical observations at the ground and, indeed, cause difficulties in any type of observations. Recent work by Adkins at Cambridge has emphasized the importance of such effects; there may be copious production of ions at the ground and a rapid vertical variation of field in the lowest layers of the atmosphere. Further, laboratory work by Hon, also at Cambridge, showed that the continuous splashing of distilled water on many types of target builds up a space-charge of negative large ions which, if not removed, completely alters the effect attending subsequent individual splashing processes.

During quasi-steady rain the electrical effects are often feeble, being comparable in intensity with those of fine weather. According to a recent systematic study by Chalmers, the typical effect in such conditions is a negative potential gradient near the ground accompanied by a downward total current (convection current on rain plus ionization current). In other words, the total current into the ground is in the reverse direction to the ionization current. Chalmers suggests that there is in the upper part of a nimbo stratus cloud some electrification process which gives the top of the cloud a positive charge, with a negatively charged region beneath; and a second process lower down, beneath the freezing-level. Dr. Wormell suggested that this second process might be due to splashing at the ground and turbulent diffusion upwards of a negative space charge on slow moving ions. The electrification in the upper part of a nimbo stratus cloud is of the same sign as the main electrification of a cumulo nimbus, and it is conceivable that the mechanism is the same. It has been common of recent years to assume that this process involves ice. Processes which have been discussed include riming, glaze ice formation and the friction or violent collision of ice particles with different electrical properties. On the other hand, the writings of C. T. R. Wilson and Vonnegut demand a reconsideration of the possibility of influence mechanisms, and the common assumption that a thunderstorm necessarily contains ice in its upper portion has been challenged.

Dr. Wormell felt that the nature of the predominant charging mechanism in thunder clouds is still far from settled, that we still lack the information necessary to make a reliable quantitative assessment of the ice processes, particularly in the presence of an electric field, and that influence mechanisms cannot yet be finally dismissed.

The meeting owed much to excellent arrangements made by the staff of the Department of Natural Philosophy, who were very generous hosts.

B. J. Mason

HILL CLIMATE

On the second morning of its summer meeting held on July 4 and 5 in the Department of Natural Philosophy, University of Glasgow, the Royal Meteorological Society directed its attention to problems of hill weather. The topics discussed were not peculiar to this branch of meteorology, as they included such general considerations as the information we have and how it can be used; the information we need and how it can be obtained; and the correlation of non-meteorological field data with weather or climatic factors.

As the main sink for observations, and the chief source of information, the Meteorological Office is the recipient of most technical and academic requests for help and advice, so it was appropriate that Mr. R. Cranna, of the Edinburgh Office, should provide the introductory paper on "Problems of Hill Climate". He quoted a number of examples to show that, apart from water balance and land utilization studies, many specific inquiries were being received which could not be adequately answered. Looking further ahead, water supply seemed to be emerging as a limiting factor in industrial development, and he foresaw that light industry might have to move to where water is available, in which event the Meteorological Office would find itself with a much bigger demand for information about hill climate. These inquiries would be for detailed wind and temperature data for

building design; wet-bulb data for cooling towers; humidity data for air conditioning; and rainfall data for sewer and drain design. Reviewing the sources of data, Mr. Cranna showed that the Scottish network of climatological stations is very open, and until fairly recently was concentrated on or near the coast. New stations set up or contemplated have improved the inland network, but vertical distribution is poor. Although one-fifth of Scotland is above 1,250 ft., there is only one station at about that height, and none higher; and since Ben Nevis Observatory was closed fifty years ago there has been no place in Scotland at which variations of weather with altitude can be studied without complicating factors. Most of the stations are set in the bottoms of glens in an effort to attain the standard ideal site—a bowling green on an infinite plain—and there is a real need for more observations on slopes. Too much of existing information is about valley climates in hill country. The observations themselves might be modified, particularly as many stations report only once daily at 0900 G.M.T., and as an example of possible improvement it was suggested that maximum and minimum wet-bulb thermometers should be part of the standard equipment.

Mr. R. W. Gloyne, also from the Meteorological Office, Edinburgh, spoke first of the classification of dissected country. There already exist concepts of ground configuration which attempt to express departures from the infinite plain, and in a brief review of some of these concepts Mr. Gloyne summarized the meteorologists' experience as indicating that, very roughly, a vertical irregularity affects local weather over a distance of about one hundred times the height. Some measure of 'ruggedness' could be useful in interpreting local climatic differences. He then gave a sketch of a possible mathematical description of a land cross-section that incorporates estimates of mean slope, ruggedness, and the extent of contact between the ground surface and the atmosphere above it.

Next he turned to climate and plant growth, and as a basis for his argument accepted the conventional definition of the growing season as the "period of the year when mean air temperature remains above 42° F.". From records in the same broad region, but at different altitudes, it was shown that the effect of increased altitude is to decrease the mean annual air temperature without any marked effect on the amplitude of the approximate sine wave, that is, the two curves are nearly parallel. The part of the curve lying above the intercepts of $T=42$ will always be shorter for the higher altitude station, but simple geometry shows that the reduction is relatively less when the amplitudes are great, that is, the change in length of growing season with altitude will be more marked in an oceanic climate than in a continental climate. Some regional regressions demonstrated the point clearly. For height H (unit, 100 ft.) and growing season L (days) the relation for southern Scotland is $L=242-4{\cdot}4\,H$; for south Devonshire it is $L=365-9{\cdot}0\,H$; that is, the shorter Scottish season is only half as sensitive to change in altitude as that of Devon. Comparisons with other parts of the world included Conrad's formula for Switzerland ($L=268-2{\cdot}1\,H$; reference level $T=43°$ F.), giving at the height of Ben Nevis a growing season of about 150 days. From the old temperature records, $L=0$ on top of Ben Nevis, and from Gloyne's equation $L=50$, but this involves a long extrapolation. The variation of growing season with altitude is obviously a very sensitive climatic discriminant.

The remaining papers came from outside the ranks of meteorology, two of them from the University of Glasgow being accounts of field-work in which attempts were made to interpret findings in terms of weather. Dr. D. H. N. Spence (Botany Department) outlined some of his ecological work on plant communities in Shetland, Rhum, the central Highlands, the Faroes and Iceland. Where there is a combination of stable soil and protection from wind (as, for example, close to a stone wall in otherwise exposed areas) a relatively close-growing community of mixed grass and heath is found, but away from such shelter it is possible to find a small number of arctic-alpine species of plants growing in the open among rock debris that consists of small stones over finer material. These sites, occurring at different altitudes in the different regions, are characterized by frost-heaving and slipping of the soil so that they occur within what is broadly the same environment everywhere. Specification of this environment is far from complete, but first attempts at correlation suggest that the mean air temperature of the warmest month is an important climatic element in it.

Soil slip was the main factor in the survey from Mr. C. A. Halstead (Geography Department) of some of the surface features of hills in southern Scotland. Between 2,200 and 2,700 ft. there is evidence of an instability in the cover of soil and mountain-top debris, the downhill movement producing terraces having a tread of the order of ten feet wide, a riser of the order of a foot, and a length of about forty feet. The treads have grassy vegetation with peat; the risers have blocky faces with bilberry. Isolated blocks of rock below such terraces appear to be sliding down-hill, producing bow-waves of turf, and grooved tracks of disturbed vegetation behind. He suggested that these features are related to a zone of maximum frequency of alternating frost and thaw. To test this speculation he has devised a simple instrument to measure the frequency with which soil temperature passes through freezing point, and is hopeful that it will help in future studies of moving soils and sliding boulders.

The remaining paper gave added point to Mr. Cranna's regret about lack of Scottish stations above 1,250 ft. Lieut.-Col. P. D. Baird (Geography Department, University of Aberdeen) has been trying to use a local site for his ice and snow studies, and to this end has himself maintained weather observations at 4,120 ft. on Ben Macdhui since February 1956. Here, just below the summit, is a near-permanent snow patch and on this, in spite of damage and difficulties produced by high winds and icing, he has been able to obtain records of temperature, humidity and wind speed throughout the period. During May–October 1956, the record was complete, and a comparison with Braemar records for the same period, and then with the long-term averages for Braemar, led him to an estimate of the probable annual cycle of mean monthly air temperatures on the mountain. On this basis, the mean annual temperature is just below freezing point. Photographs were used to show the contraction of the snow patch during the summer, the drift of 30-ft. depth just surviving in 1956, but not in 1955, and—confidently—it cannot survive in 1957. Time was too short for more than a very brief discussion of the ablation process, but it seemed clear to Col. Baird that air conduction and

convection play an overwhelming part in it, that is, the dominant factors are aerodynamic rather than radiative.

The arduous mountain ascents, often in bad weather, need have been made much less frequently if there had been an automatic weather station available, but there has been no British development of such an aid to climatology. Much more to be regretted is the complete absence of any manned mountain weather station. Other less wealthy countries regard these as essential, and Col. Baird's final plea was for the establishment of at least one in the British Isles.

The brisk discussion brought out useful criticisms, comments and questions from physicist, climatologist, geographer, and ecologist, and it was exhaustion of available time that forced its closure by the chairman.

H. L. Penman

ENDOCRINOLOGICAL PROBLEMS IN AGRICULTURE

By Dr. I. W. ROWLANDS

Agricultural Research Council Institute of Animal Physiology, Babraham, Cambridge

THE rapid growth of the science of endocrinology beginning about thirty years ago arose from the discovery that the pituitary gland regulates body growth and the functional activity of the gonads and other endocrine organs. The past three decades have witnessed the separation and purification of growth hormone (somatotrophin), thyrotrophin, gonadotrophin (follicle-stimulating hormone and luteinizing hormone), adrenocorticotrophin and prolactin (or luteotrophin) from the pituitary gland and the chemical characterization of steroid hormones, œstradiol, progesterone and testosterone from the gonads, together with many of their metabolites from urine. A variety of substances having hormone-like actions (for example, diethylstilbœstrol) have been synthesized, and in more recent years, a wide range of pure hormones have been isolated from that endocrinological enigma, the adrenal cortex. Armed with these new products, physiologists and biologists have attempted meanwhile to appropriate to each its precise biological function and to determine its role in the complex hormonal mechanisms which exist in the animal body. One important result of the extensive studies made in laboratory animals is the absence of any great measure of uniformity in the response of different species to the same hormonal stimulus. Our understanding of the role of hormones in the endocrine mechanisms of the large domestic species cannot, therefore, be obtained by inference; every species requires separate and individual investigation.

The Agricultural Research Council, in October 1952, assembled a committee known as the Technical Committee on Endocrinology consisting of eight specialists in various branches of the subject, with Dr. S. J. Folley as its chairman, to keep under review all endocrine problems in farm animals, and to recommend to the Council research projects within this field which it considered to be of value to the farming community and also those which would advance basic knowledge. After between three and four years work, during which a total of twenty-three scientific memoranda on a wide variety of subjects were prepared and discussed by its members and co-opted specialists, the Committee has submitted a report to the Council. Some of the earlier reviews have become out-dated by the rapid march of events in this science, so that publication of all the papers as a book is being withheld; but in view of the breadth of their scientific interest a list of titles and dates of preparation of memoranda is being prepared by the Council* which will be made available on request to interested research workers. Memoranda selected from this list will be sent on application.

The earlier memoranda concern the regulation of the reproductive processes. They include the role of external stimuli, for example, daylight and day-length, on hormone secretion and the various neuro-hormonal mechanisms which more recent work has exposed. In regard to the former, attention was directed to the need for further fundamental studies on the mode of transmission of the light stimulus to the pituitary gland which is necessary for the evocation of reproductive activity in animals breeding seasonally. Its elucidation would supply a background of information which would be useful to workers interested in the hormonal induction of œstrus and fertility in anœstrous sheep, on the lactational performance in cows and in egg-production in hens. Two of the memoranda on neuro-hormonal mechanisms favour the extension of research into the mode of release of hormones, especially those from the pituitary gland. Much of this work is of considerable academic interest to the neuro-endocrinologist and has also an important bearing on animal husbandry. The vigorous prosecution of research is recommended into (*a*) milk ejection in cows, (*b*) sperm transport in the female reproductive tract, (*c*) the temporal relation between mating and ovulation, (*d*) parturition and (*e*) suckling. The elucidation of the mechanism integrating the continuous release of the anterior lobe hormone (prolactin) and the intermittent, reflex stimulation of secretion (oxytocin) from the neurohypophysis is of special interest.

Further advances in many branches of endocrinology are seriously impeded by the lack of assay methods of sufficient precision and sensitivity of identify and measure the very small amounts to various steroids circulating in the blood and tissues of normal animals. Special mention is made of the bio-assay of progesterone as being the key to the problem of evaluating the relative activities of the corpus luteum and the placenta in the maintenance of fœtal life. Of no less urgency is the need to discover sensitive methods for the bio-assay of adrenal hormones, in order to elucidate the metabolism of corticosteroids in ruminants as a preliminary to further research into physiological abnormalities such as parturient paresis and ketosis in farm animals.

* Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1.

The problem of increasing the reproductive capacity or prolificacy of farm animals continues to attract a large amount of attention. In sheep the object has been the increase in the number of twin lambs by hormonal (gonadotrophic) stimulation of the ovaries during the normal breeding season or during anœstrus. Very promising results have been reported on the use of a single injection of serum gonadotrophin preceded by a short course of injections of progesterone as a method for the induction of ovulation and œstrus in the ewe during anœstrus; but the method will remain impracticable for large-scale use until it can be simplified. Even then, the usefulness of the procedure might well be restricted by agricultural considerations, such as shortage of good grazing.

In polytocous species, prolificacy would be increased if a larger number of the eggs which leave the ovaries became fertilized and developed normally to term. Pre-natal mortality at various stages of the reproductive process in the pig is known to reduce, to an important extent, the number of young that are born. The causes of embryonic mortality in this and other species are largely unknown but would seem to be varied in character. Thus, preliminary work has indicated the existence of strains exhibiting high and low levels of fœtal loss, and of a genetic factor carried by the boar which facilitates implantation of the developing egg and the maintenance of gestation in his daughters. This and other factors concerned in fertilization, implantation and the maintenance of gestation are being investigated in a programme of research into the physiology of reproduction in the pig.

Breeding experiments to improve the genetic constitution of farm animals take many years to complete, because of the long interval between succeeding generations. Experiments on the transfer of fertilized eggs are being performed, however, to reduce the generation-interval in cows. These make use of the fact that the ovaries of the new-born calf are very sensitive to stimulation by gonadotrophins and that ovulation can be induced in very early life. The aim is to transfer eggs after fertilization from the uterus of the calf to that of a mature cow, so that the interval between generations can be shortened by a period equivalent in length to that taken by the newly-born calf to reach full sexual maturity. This technique, when perfected, will have various applications in the breeding of high-quality beef and dairy cattle.

Research into the endocrinology and physiology of lactation is fully justified by the nutritional importance of milk as an agricultural product. The dependence of lactation, no less than that of mammary growth itself, on hormonal action is commonplace. An immense amount of work has been done already, but the complete story is not yet unfolded. A memorandum provides many suggestions for future studies to unravel the action of anterior pituitary hormones on milk-secretion. It urges the use of hypophysectomized goats as a substitute for the cow for the study of the influence of these hormones in the maintenance of lactation.

A further indication of the complex nature of the hormonal control of lactation is given by the fact that milk-secretion in goats, which ceases abruptly after bilateral adrenalectomy, could only be maintained after this operation by the synergistic action of a mineralocorticoid (deoxycorticosterone) and a glucocorticoid (cortisone). For future work, it has been suggested that the composition of the milk secreted in response to injected corticosteroids should be carefully analysed to give a possible lead to the precise role of these hormones in lactation.

Extensive trials were given during the Second World War to the use of synthetic œstrogens, thyroxine and iodinated proteins for the induction of lactation in virgin heifers and barren cows as a practical method of augmenting the national milk-supply. No entirely satisfactory method was discovered of counteracting the great variability in the response of different animals to treatment with œstrogens, and the production of deleterious side-effects by these substances led to the abandonment of the project. Recent investigations have shown that a greater measure of control of mammary response to œstrogen is possible if progesterone is used simultaneously. This introduces new hope; but the problem of dissociating the untoward actions of œstrogen from its mammogenic and lactogenic properties awaits solution. Studies should be made of the factors governing maximum udder growth during pregnancy and for this research work it was recommended that poor-quality cows in late pregnancy might be used.

The evidence presented on the usefulness of hormones as agents to secure rapid growth and fattening of young animals is equivocal. Experiments on small animals have shown that hypophysial growth hormone increases appetite and the deposition of protein, but that unrestricted feeding, which may render any project uneconomic, is required to overcome the effect of the hormone on the depletion of fat. There is, however, an indication that the deposition of protein depends on the availability of insulin. The results obtained on the fattening of pigs using stilbœstrol, androgens and anti-thyroid drugs (thiouracil), too, have not been an unqualified success, although results offering more promise have been obtained from the combined feeding of stilbœstrol and thyroxine to castrated male pigs. The widespread interest in the United States concerning the use of stilbœstrol as a fattening agent for sheep and cattle called for the initiation of similar work in Britain. At the same time, concern was felt about the coincidental production of untoward side effects (for example, hyperostosis) by the œstrogen, but ways were suggested by which these may be counteracted. Furthermore, the possible contamination of the carcass, especially the fat, with œstrogen should not be overlooked.

Two other memoranda deal with certain aspects of the relation of hormones and nutrition in animals, and many recommendations have been made for further research in which chemical methods for the determination of seminal constituents could be employed to evaluate the effect of hormone administration in animals under various conditions of nutrition. Moreover, the effects of specific food components, for example, vitamins, trace elements, amino-acids and fatty acids, on testicular activity could be assessed by this method. The need for co-incidental studies on the spermatogenic function of the testis and the fertilizing capacity of sperm and the advantages to be gained from the use of monozygotic twins are apparent.

The outstanding problems concerning the role of hormones in the control of reproduction in birds are mentioned in a memorandum which also expresses concern over the lack of endocrinologists in Britain who are interested in the fowl as a laboratory animal.

This animal deserves a far greater measure of scientific investigation than it now receives, especially in view of the already great, and still growing, value of the poultry industry. The memorandum recommends that efforts be made to attract young workers into this field of research to investigate such problems as the endocrine control of the secretory activity of the oviduct, the role of hormones in the moult and broodiness in hens and the action of hormones on the differentiation of sex and on gonadal development. The Poultry Research Centre has facilities for intensifying its research programme along these lines if the scientists become available to conduct the work.

There would appear to be a close connexion between endocrinology and genetics; but there are, in fact, only a few examples in support of this contention. The relation between these two subjects was discussed at a meeting to which eminent geneticists were invited. Much closer co-operation than had previously existed between workers in these two sciences was thought desirable for their mutual benefit in the resolution of many complex problems.

No direct approach has been made to the problem of infertility due to physiological causes in farm animals, except in so far as it may arise from the ingestion of œstrogenic substances in pasture plants. Such a substance has been isolated from red clover and some British grasses in concentrations equivalent to 2–6 μgm. of the naturally occurring œstrogen per gram of the dried plant. It would not seem to be directly responsible for the rise in percentage of non-fatty solids of the milk of cows put out to graze after prolonged periods of stall feeding; but it is considered feasible that the intermittent occurrence of short periods of herd-infertility which has been reported in cattle might be attributed to sudden changes in the amounts of œstrogen ingested. If this be the case, failure to reproduce would most likely result from the inability of the blastocyst to become implanted because of the disturbance to the œstrogen–progesterone equilibrium.

The reviews which have been discussed by the Committee by no means exhaust the topics that could be presented on endocrinological problems in agriculture. Nevertheless, they give a broad glimpse of the many pathways along which future research could benefit the farming industry. Already, the first steps have been taken along several of these paths.

A CODE FOR PROTECTION AGAINST RADIATION

FOR the first time a comprehensive manual on the protection of radiological workers has been issued by the Office of the Prime Minister and First Lord of the Treasury (Atomic Energy), Ministry of Health, Department of Health for Scotland and Ministry of Health and Local Government for Northern Ireland*. This does not imply, however, that radiation protection has hitherto been neglected, either in hospitals or by other responsible authorities in Britain. So long ago as 1921 the British X-ray and Radium Protection Committee was formed, largely as a result of the pioneering work of Prof. Sydney Russ, "with the object of arresting the sequence of casualties to X-ray and radium workers". Many of the recommendations of the British Committee were adopted by the International Commission on Radiological Protection in 1928, and the Committee continued in being until 1948, when it published the seventh and last revision of its report. For more than a quarter of a century the recommendations of the British Committee formed the basis of radiological protection in Britain. These recommendations have been supplemented over the past ten years by an "Introductory Manual on the Control of Health Hazards from Radioactive Materials", prepared for the Medical Research Council by the Ministry of Supply, Atomic Energy Research Establishment.

The new "Code of Practice for the Protection of Persons exposed to Ionizing Radiations" is designed to meet the needs of an age in which the production, variety and uses of radioactive materials have enormously increased. This informative and extremely useful manual has been prepared by a distinguished committee, with Sir Charles Darwin as chairman, which was set up under the Radioactive Substances Act to advise Ministers on questions of radiation protection. The Code is based on the scientific findings of other bodies, notably on the recommendations of the International Commission on Radiological Protection (1955) and on the Medical Research Council's report on "The Hazards to Man of Nuclear and Allied Radiations" (1956).

The general rules of the Code make it clear that the officer in charge of a department in which ionizing radiations are used is responsible for the radiological safety of the staff. It is advised further that one member of such a department should be designated as safety officer, to be responsible for the necessary protection measures. The word 'must' is used to indicate essential requirements and the word 'should' reserved for desirable but presumably not always necessary or practicable requirements. Every employee must, in future, sign a statement that he has read and understood those sections of the Code applying to the circumstances of his work.

The Code of Practice is presented in two parts: Part *A* deals with the use of X-rays for diagnostic purposes and the use of X-rays and γ-ray beam units for therapeutic purposes; Part *B* concerns the medical uses of radioactive isotopes, sealed or unsealed. In both parts rules of protection are laid down without detailed specifications about installations or techniques, but no important points are overlooked. Part *A*, for example, contains all the minimal requirements for X-ray tube housings, diaphragms, fluorescent screens, observation windows, protective clothing, etc., and Part *B* gives most valuable information on the types of laboratory required for different levels of activity of radioisotopes of various defined grades of toxicity. Practical details are also given relating instrument response to levels of contamination and describing sensible procedures to be followed if radioactive materials are spilt. No rules are yet given on the

* Code of Practice for the Protection of Persons exposed to Ionizing Radiations. Pp. iv+83. (London: H.M. Stationery Office, 1957.) 8s. net.

disposal of radioactive waste; this problem, which impinges on some of the responsibilities of local authorities, is still under consideration.

One half of the eighty-odd pages of the manual is given to a well-planned supplement which admirably summarizes the essential findings of the International Commission on Radiological Protection (1955) and gives the technical information necessary for implementation of the rules of Parts *A* and *B*. This section also includes a glossary defining all the technical terms appearing in the manual.

Comparison of the new Code with the older recommendations illustrates the increasingly cautious attitude now taken towards any irradiation of human beings additional to that received from natural sources. The earliest recommendation of a 'tolerance dose' of 1 r. per week has been gradually abandoned in favour of a 'maximum permissible dose' of 0·3 r. per week, now accompanied by still stricter provisions in terms of maximum cumulative doses for whole-body exposure. The limits applicable for exposure up to thirty years of age and per decade thereafter are equivalent to an average weekly dose of 0·1 r. "This is one-third of the maximum permissible weekly dose. In the case of long-term exposure, the protection must be planned accordingly" (Code, p. 52).

On the other hand, less emphasis than formerly is placed upon the necessity for regular blood counts. Provided adequate radiation monitoring is carried out in all circumstances involving occupational exposure, routine blood counts are suggested only in the case of workers who receive average doses exceeding one-half the maximum permissible weekly level averaged over a period of three months, and in the event of a worker acquiring a significant amount of an isotope deposited internally. Presumably the Committee considered that doses of radiation insufficient to affect the blood count could be harmful and that a blood count therefore afforded insufficient security at the lower dose-levels. Even so, the blood count does offer a biological test which cannot be circumvented accidentally or intentionally by anyone, and which can give an indication of high doses which for a number of reasons could be missed by purely physical monitoring.

Hours of work receive no mention in the Code, although the British X-ray and Radium Protection Committee was forthright on this point, recommending a five-day week, "the off-days to be spent as much as possible out-of-doors and not less than four weeks holiday a year, preferably consecutively". No reason is given for this omission in the present Code. It is convenient administratively and it is probably correct to formulate regulations for radiation safety apart from rules about working hours but, in my opinion, it would be unwise to separate these considerations in the case of hospital radiological staff who, in their daily contact with the sick, are exposed to the risk of infection as well as to an agent noted for its toxicity to the blood-forming tissues.

A very great service, however, has been performed by Sir Charles Darwin and his colleagues in producing so useful and valuable a document, which has a field of application much wider than hospital radiological work. The manual must be in the hands of all those who use ionizing radiations in the National Health Service; it should—and almost certainly will—be beside all others who use ionizing radiations for any purpose whatever.

The Minister of Labour and National Service has recently issued a preliminary draft of a new Code of Regulations to safeguard workers employed in industry against the effect of ionizing radiations (Factories (Ionizing Radiations) special Regulations: Preliminary Draft. Pp. 16. H.M. Stationery Office. 9*d*. net). The regulations deal with industrial X-rays and sealed radioactive sources. Draft regulations to deal with unsealed or open sources are in the course of preparation.

F. W. SPIERS

OBITUARIES

The Right Hon. Viscount Cherwell, P.C., C.H., F.R.S.

FREDERICK ALEXANDER LINDEMANN, Viscount Cherwell, was born in Baden-Baden on April 5, 1886, and died in Oxford on July 3, 1957. His father, a naturalized Briton who came from an Alsatian family of French loyalty, was a wealthy engineer; his mother was English. He shared with his father an interest in astronomy and in instrument-making; and physics and mathematics became his principal subjects when he studied at the University of Berlin under Rubens, Planck and Nernst.

His Ph.D. dissertation was completed in 1910; it was on the atomic heats of metals at low temperatures, and with Nernst he published some important papers on this subject. Altogether he produced nearly twenty papers before 1915; besides the atomic heat work they dealt with subjects as varied as a glass transparent to X-rays ('Lindemann glass'—published jointly with his physicist brother, now Brigadier C. L. Lindemann), astrophysics, and his well-known melting-point formula. The last, which was the subject of his first independent paper, was characteristic: his simple physical model of a crystal lattice melting when its atoms oscillate so violently as to hit their neighbours enabled him to relate, with a minimum of calculation, the melting-point of a material to its Einstein single frequency.

Lindemann's strong loyalty to Britain cut short all this work in 1914, for it took him to the Royal Aircraft Establishment at Farnborough, where he was one of several outstanding physicists who devoted themselves to the many problems arising in the new field of aeronautics. Most of his work was concerned with the instruments of flight; but he is best known for his diagnosis of the way to recover an aircraft from the hitherto fatal condition of spinning. He had learnt to fly, and he undertook the trials himself: their success matched his courage, and Lindemann's technique became a standard drill. It has been said that he was not a good pilot, but it should be remembered that there was no obligation whatever for him to fly, and furthermore that he had only one good eye. He doubted the advantages of binocular vision, and would point out that he "had not done too badly" at tennis without it. Indeed, he had won several championships in Germany and

Sweden before 1914, and competed honourably at Wimbledon after he had become Dr. Lee's professor of experimental philosophy at Oxford in 1919. In that year, incidentally, he published with F. W. Aston a paper on the possibility of separating isotopes which suggested many of the methods afterwards used.

Lindemann's appetite for action outside the purely academic plane may have been so whetted by his Farnborough experiences that he could not again settle into research with his pre-war vigour. In addition, the load of a chair and a department which had been almost moribund for many years may have limited his personal research. His papers appeared less regularly ; the most outstanding were those with G. M. B. Dobson on meteors, with the important and correct conjecture that there was a warm layer in the Earth's outer atmosphere, and that with his father and T. C. Keeley on the instrument now known as the Lindemann electrometer. This originated in the need for a small, sensitive electrometer for use with the photoelectric cells of outstanding sensitivity that had been made under Lindemann's leadership in the Clarendon Laboratory. In the meantime, in one of the heroic ages of physics, the structure of quantum mechanics was being built, and Lindemann's contribution was a book—"The Physical Significance of the Quantum Theory", published in 1932—in which he developed with characteristic ingenuity and insight the applications of the principle of indeterminacy. The book was elegantly and concisely written, and still merits attention.

Lindemann's direction of the Clarendon Laboratory was for some time as diverse as the subjects of his papers ; apart from photoelectricity there was no main line of steady research. This was rather hard on new research students, each of whom might have to enter a new field with a minimum of briefing. For the stronger men the system was good : their abilities had already been tested by the unusual and stimulating examinations which Lindemann had set, and their independence of thought and self-reliance were enhanced by their individual researches. If they succeeded, no professor could have been more generous than Lindemann in keeping his name out of their publications. But the result was a series of isolated researches in each of which much effort had to be expended in surmounting the difficulties of entering a new field, and the position of the Clarendon was still scarcely commensurate with its seniority among the world's laboratories. In 1933, however, Lindemann became one of the main sponsors of refuge for the Jewish scientists in Germany. He had been a constant visitor to the Continent since boyhood, and he appreciated very early the significance of the Nazi movement. Among those to whom he offered refuge was Prof. Franz (later Sir Francis) Simon, and under Simon's leadership the reputation of low-temperature physics at the Clarendon grew rapidly. At the same time, the survivors of the earlier 'sink or swim' phase were producing notable work.

It was not easy to convince Oxford of the needs of physics, or indeed of science in general. Even in 1939 there were only about six fellowships in physics in the whole University. Part of Lindemann's achievement is that he did ultimately succeed in awakening the University to the importance of the subject, with the result that the new Clarendon Laboratory was built and opened in 1939, and new fellowships were created. The new laboratory was the best of its kind in Britain, and fortunately the staff was kept substantially intact throughout the War to work on problems of microwave generation and isotope separation. This enabled the Clarendon to start research again, immediately after the War, with all the apparatus and techniques acquired in the meantime. Lindemann had come to the Clarendon when almost no research was being done ; he left it, on voluntary retirement in 1956, a well-equipped laboratory with a great reputation. This end had constantly been before him and, while his way of attaining it had not been entirely the traditional one of personal example and leadership in research, the credit is his.

It is rare, but not unique, for a man of science to be closely associated with a statesman. J. H. Poynting wrote papers of the 'operational research' type at the request of his friend, Joseph Chamberlain. The latter's son, Austen, was among the friends of Lindemann, who had become well known in the 1920's to several senior members of the Conservative Party. His friendship with Sir Winston Churchill and their collaboration from 1932 onwards is part of our history. Their joint stand with Austen Chamberlain on the scientific possibilities of air defence in 1934 and 1935 was one of the factors which led to our being ready just in time for 1940. Here again, Lindemann's methods were not those usual to academic men. An individualist, he unsuccessfully stood for election to Parliament in 1937, while other physicists, with an equal sense of duty, had joined in a committee to help the Air Ministry directly. The happiest verdict on this, at times painful, difference may also be the true one : that the Air Ministry and the country benefited greatly from the committee's work, and from Lindemann's independent approach.

When the Second World War broke out, Mr. Churchill called Lindemann to the Admiralty as his scientific adviser, and when the former became Prime Minister in 1940, the latter moved to the Cabinet Offices ; he was appointed a formal member of the Government as Paymaster-General in 1942. He remained in this post until 1945, when he returned to Oxford, and he became Paymaster-General again from 1951 until 1953 at Mr. Churchill's request. The flair for simple physical models that was evident in his scientific papers was invaluable in making clear to the Prime Minister in "lucid, homely terms" what the scientific issues were in any problem regarding new weapons. Lindemann's influence on the scientific policy decisions of the War, and from 1951 onwards, was great. He was always prepared to take an unpopular stand, as in 1940 when he refused to believe the accuracy of our bombing claims ; his persistent scepticism revealed the facts, and resulted in a complete switch to radio navigational aids to bombing.

By no means all his advice would have been endorsed by other men of science. In particular, he could not resist the very quickness of his mind leading him to form a theory from a minimum of fact ; and having once committed himself to the theory, he would be reluctant to accept any subsequent fact that disagreed with it. Moreover, behind a misleadingly aloof exterior he had great warmth of feeling, with strong likes and dislikes, so that his acceptance or contradiction of a particular point of view would sometimes much depend on how he felt towards the

propounder. These factors—intense loyalty to his theories and his friends—detracted at times from the balance of his judgment; but when this has been admitted, there is much to be grateful for. His criticisms were courageous in expression and stimulating in effect. My own experience is coloured by the memory of his insisting on my being called to give my views on the reality of the *V*2 rocket threat, to a War Cabinet meeting of 1943, despite the fact that he knew that I—much his junior and his pupil—was going to differ completely from his own conclusions; and although he was not right about the rocket, it was in part due to his prescience that we were not blind to the parallel threat of the flying bomb.

As a relaxation from the strain of Whitehall during the War, he pursued a long-standing interest in the theory of numbers. In 1933 he had published a very direct and elegant proof of the fundamental theorem of arithmetic, and he now followed this by a heuristic proof of formulæ for the frequency of occurrence of prime-pairs, prime-triplets and other combinations. Unknown to him, these formulæ, which he confirmed by counts, had been found by much more elaborate (and equally non-rigorous) methods by Hardy and Littlewood and by Staeckel, but Lindemann's methods were much simpler and more illuminating; no rigorous proof has yet been found.

In the field of nuclear energy, his advice must have been vital. For a long time it was doubtful whether he was convinced that a nuclear bomb was possible. The idea of such destructive power being available to human hands seemed to repel him so much that he could scarcely believe that the universe was constructed in this way; and it is perhaps against this background that some of the war-time decisions about nuclear energy should be construed.

After the War, he keenly supported the setting up of a separate Atomic Energy Authority, and he was a member of the Authority for the last three years of his life. He was also much concerned with general policy in science and technology, and he was intensely anxious to see both the cultural and material value of science more adequately appreciated in Britain and the status of men of science enhanced. He made speeches of impressive content on all these matters in the House of Lords. They sometimes resulted in controversy, but there will surely be universal agreement with this confession of faith which he made in a debate on university education on May 14, 1947:

"The function of a university teacher, as I see it, is to develop in young people the habits of exact and logical thought, to show them how and where the underlying facts can be ascertained on which conclusions are to be based, to indicate how the great minds of the past have tackled problems, to show what conclusions they have reached and how they have justified them, and, above all, perhaps most important of all, to arouse the students' curiosity and interest and stimulate them to the point of making the students desire to spend laborious days and nights in an effort to contribute themselves something towards the advance of knowledge."

Cherwell had an unusual range of honours. He was elected to the Royal Society in 1920, and he was awarded the Hughes Medal for 1956. He was created Baron Cherwell in 1941, a Privy Councillor in 1943, a Companion of Honour in 1953, and he was raised to a Viscounty in 1956. He received the Messel Medal of the Society of Chemical Industry, and the LL.D. degree of the University of Aberdeen.

He was not a professional physicist in the sense of having to make his living by physics, since he was wealthy enough by inheritance to have lived in comfort without working. His interest in physics was thus all the purer, and his independence the greater; at times he accepted no salary for his work for the Government. His will provides for substantial bequests to Christ Church and Wadham College, Oxford, and expresses the wish that these bequests be applied to the foundation of fellowships or studentships for teaching and research in the physical sciences, including astronomy.

Something of his personality will have been evident from this appreciation. His loyalties to Britain and to science transcended all his feelings and permeated the great width of his interests. His wit, his anecdotes, his arguments and his aloofness were the subjects of many 'high-table' stories. His aloofness, however, was easily penetrated by anyone in misfortune; he would go to much trouble to answer a request for help, or to provide help before it had been asked. He placed surpassing value on his friendship with Sir Winston Churchill and on the tenure of his chair; and he faithfully returned to Oxford in 1953 because, he said, the chair was the substance and politics the shadow. The very fact that at critical periods he was in the innermost circles of government and of international relations gave confidence to other men of science that their language and their thoughts would be understood in those circles: and as an ambassador of science when it was first entering directly into the destinies of nations, he commanded the respect and earned the affection of the statesmen with whom he so loyally worked.

R. V. Jones

Dr. Irving Langmuir, For.Mem.R.S.

In an age of ever-increasing specialization, it is given to few to open up new vistas in many fields and to make notable advances in both academic and industrial worlds. Such a man was Irving Langmuir, whose recent death at the age of seventy-six has left such a gap in the select band of the élite of modern scientists.

Langmuir, who had been a teacher in the small academic Stevens Institute, Hoboken, New Jersey, was invited by Dr. Whitney, director of the Research Laboratory of the General Electric Co., Schenectady, to enter that Laboratory in the summer of 1909. Instead of being assigned some particular problem, Langmuir was given a free hand in following the various investigations current at that time. He was attracted to the problem of the cause of brittleness in drawn tungsten wire, which Coolidge had then recently developed, and suspected that gaseous impurities occluded in the wire might be the cause. Whitney suggested that he might examine this possibility in more detail, and thus started that series of monumental investigations on the interaction of gases with, and at, the surface of metals, with which the name of Langmuir will always be associated.

Apart from the implication of this work for the problem of heterogeneous catalysis, there emerged, in the form of as it were by-products of his work, fundamental inquiries such as the rigorous computation of the loss of heat from hot filaments, the mer-

cury-jet vacuum pump, the nitrogen gas-filled incandescent electric lamp, the evaluation of the heat of dissociation of hydrogen and the use of atomic hydrogen in welding.

It is interesting to note that Langmuir extended his investigations on the processes of evaporation and condensation to the case of the alkali metals on tungsten, where evaporation of atoms, ions and electrons can be observed and the phenomenon of surface mobility most readily demonstrated. The recent developments in our theories of heterogeneous catalysis are beginning to emphasize the importance of these contributions carried out nearly thirty years ago.

Langmuir soon discovered that these reactions taking place with heated tungsten filaments and gases at low pressures involved but a single layer of atoms on the surface of the metal, which he likened to a checker-board of free valencies. Furthermore, from his studies on the reactions of carbon and its oxides at high temperatures, he concluded that the properties of adsorbed films should in general depend on the orientation of the molecules or radicals in the film with respect to the substrate, and that this hypothesis could be examined most conveniently at liquid surfaces. These inquiries resulted in the now famous series of papers published in 1916 and 1917, in which the concept of the orientated monolayer was developed and the evidence for molecular orientation at the surface of liquids tested by a series of ingenious and simple experiments.

It is of interest to note that this concept of molecular orientation at interfaces was being developed simultaneously but by very different paths by Prof. Devaux in Paris and Sir William Hardy in Cambridge.

Such molecular orientation is due to the operation of short-range forces which vary in magnitude over different portions of the molecules concerned, and Langmuir extended this view of surface orientation to computation of the properties of binary liquid systems, making use of the hypothesis of independent surface action.

During the Second World War, Langmuir was engaged on the problem of screening by means of smoke and of the de-icing of aircraft. For a few years before his death, he, together with his colleague Dr. V. Schaefer, took up the problem in a new form, namely, the modification of clouds and the control of weather by the method of chemical seeding.

Those of us who have had the honour and the pleasure of long acquaintance with him and Mrs. Langmuir, and have seen both his experiments on the clean-up of nitrogen in the laboratory and his detection of black widow spiders with the aid of a flash lamp at Lake George, will always carry in their minds the memory of a man unspoilt by the many honours bestowed upon him, a man unrivalled in his power of observation and directness of thought, one who could impart his ideas to others with that simplicity which is the mark of the truly great and one whose friendship did not change with the years.

Eric K. Rideal

NEWS and VIEWS

Union Astronomer at Johannesburg: Dr. W. H. van den Bos

Dr. W. H. van den Bos, who retired at the end of 1956 from the post of Union Astronomer at Johannesburg, is one of a considerable number of astronomers who went abroad after studying astronomy under Prof. W. de Sitter at Leyden. He went to Johannesburg as Leyden observer in 1925, and shortly afterwards was taken on to the permanent staff as chief assistant. In 1941 he was promoted to the directorship of the Observatory. His chief interest has been in double stars, and it may fairly be claimed for him that he did for the southern hemisphere what Aitken had done for the northern—complete the survey of all stars down to a definite brightness and measure systematically at two or more epochs all the double stars he found. He has been recognized for many years as the leader in his chosen field, was president of the commission on double stars of the International Astronomical Union and kept up to date a compilation of all measures of southern double stars, now being incorporated with a similar compilation for northern stars. After his retirement he is spending a year in the United States measuring at the Lick, MacDonald and Yerkes Observatories the most important double stars, for which there are not adequate observers in the northern hemisphere. Astronomers look forward to the results of his new labours.

Dr. W. S. Finsen

Dr. W. S. Finsen, who has succeeded Dr. van den Bos, is an astronomer trained in South Africa, whose chief observing activities have also concerned double stars. He is, moreover, extremely interested in instrumental design and has himself constructed new delicate pieces of apparatus. He is best known for his stellar interferometer for measuring the closest and therefore the most important double stars. By the observation of the brightest stars, he has discovered new and very close doubles. He should prove a useful director of the Observatory in undertaking a new exact time service and in the construction and erection of a large reflector at a site away from Johannesburg at Hartbeespoort.

Regius Professorship of Physic in Cambridge: Prof. J. S. Mitchell, C.B.E., F.R.S.

Prof. J. S. Mitchell, who has been appointed regius professor of physic in the University of Cambridge in succession to the late Sir Lionel Whitby, was born in 1909. He entered the Medical School of the University of Birmingham in 1926, and later won a scholarship to St. John's College, Cambridge; here he took a double first, including Part II physics. After completing his clinical training at Birmingham he qualified with the Cambridge M.B. in 1933 and became house physician to Prof. K. D. Wilkinson. A Beit Memorial Fellowship in the Colloid Science Laboratory at Cambridge under the supervision of Sir Eric Rideal was followed by a fellowship at St. John's in 1936, and he eventually became assistant in research in radiotherapy at Addenbrooke's Hospital, where he was closely associated with the late Prof. J. M. Ryle in the Department of Medicine.

During the War, after a period in the Emergency Medical Services, he was in charge of medical

investigations in the National Research Council Laboratory at Montreal, until in 1946 he was elected professor of radiotherapeutics in the University of Cambridge. In his own department at Addenbrooke's he started regular joint clinics with physicians, surgeons and specialists in charge of special departments, and these have become an increasingly important factor in integration. His approach is always as a physician using radiation as a method of medical treatment. In research he has ranged widely, but of recent years his topics have included the design and conduct of clinical trials of new methods of treatment of cancer, the chemotherapy of cancer, the radiotherapy of malignant tumours with especial reference to the 30-million volt synchrotron and the clinical applications of radioactive isotopes. His considerable scientific attainments are matched by his kindness and concern for the well-being of his patients. He was made C.B.E. in 1951 and elected to the Royal Society in the following year. As regius professor of physic at Cambridge he is well equipped not only scientifically and clinically, but also by local knowledge of the organization of the University and of the region, to direct the development of the Cambridge Medical School.

Athanasius Kircher

THE magic lantern is said to have been invented by Athanasius Kircher, the date being given variously as 1646, 1664 or 1671. In the *Observer* exhibition held last summer in London he was featured, along with Lucretius, Ptolemy and Leonardo da Vinci, as "discovering a principle involved in Cinematography", and in a history of the silent film published last year in Germany—"Unsterblicher Film", by Heinrich Fraenkel—he is mentioned as having converted the camera obscura into a magic lantern. In his "History of Light", published in 1772, Joseph Priestley says with reference to Kircher, "we are perhaps, at this day, most obliged to him for his ingenious contrivance of the Magic Lantern . . . Those who chuse to see Kircher's own drawing of this ingenious instrument will find some very fine ones in his *Ars Magna Lucis et Umbrae*". Whether or not Kircher did invent the magic lantern has been fully investigated by Dr. P. A. Houston (*Sci. Prog.*, 45, No. 179; July 1957); the investigations show that almost certainly Kircher did not invent the magic lantern and deserved the epithets given to him by a writer in the *Allgemeine Deutsche Biographie*. "I have gone into these works of Kircher in detail," he said, "because it was my purpose to show him as the charlatan he was. He had a many-sided education and great zeal, but only superficial knowledge, and no idea of method; he was a diligent worker, but he was neither reliable nor thorough. He was not the researcher for whom it is sufficient if the experts appreciate his work; what his nature required was the empty admiration of the so-called 'wider circles' and to retain this he stooped to falsification."

World Federation of Scientific Workers

THE fifth General Assembly of the World Federation of Scientific Workers was held in Helsinki during August 29–September 2. Fifty-three representatives from eighteen countries were present and the delegates included Academicians Chou Pei Yuan (China), A. I. Oparin (U.S.S.R.), I. Malek (Czechoslovakia) and Profs. J. D. Bernal and C. F. Powell (Great Britain). Apart from the discussion of internal affairs of the Federation, there were two symposia on "The Planning of Science" and "Scientific and Technological Training", respectively. The planning of scientific work has now become important in many countries with differing social and economic systems. This symposium provided a valuable opportunity for an exchange of ideas and information concerning the practical consequences of planning. The second symposium gave an opportunity for reviewing what had been achieved in this field in a number of countries. Many of the problems of curricula and organization are common to all countries and evidently arise from the rapidity with which science has developed in recent times. The sandwich courses which are being developed in Great Britain are an innovation as yet little known abroad. The symposium served to emphasize what is already well known, namely, that the total number of students undergoing higher education in the U.S.S.R. is very high compared with Great Britain.

Prof. C. F. Powell was elected president of the Federation in succession to Prof. F. Joliot-Curie, and the new vice-presidents are Academician Li Szekwang (China), Academician A. I. Oparin (U.S.S.R.), Prof. C. Sadron (France), Dr. G. P. Nørregård (Denmark) and Prof. J. D. Bernal (Great Britain). After the conclusion of the Assembly, all members were invited to go to Leningrad as the guests of the Union of Higher Educational and Scientific Workers of the U.S.S.R. The thirty-three representatives who went to Leningrad were able to make contact with the scientific institutes of the Academy of Sciences and with departments of the University of Leningrad. Visits to places of historic and artistic interest were also arranged.

Geochemistry

A SYMPOSIUM on geochemistry was held in Paris during July 22–24 under the auspices of the International Union of Pure and Applied Chemistry. It was organized by the local chairman, Prof. E. Raguin, and presided over by Prof. T. F. W. Barth with Prof. K. Rankama acting as a secretary. One hundred and fifteen members, representing eighteen countries, were present, and fifty-two papers were read and discussed. The subjects dealt with comprised geochemical aspects of cosmology, distribution of chemical elements, geochemical aspects of rocks and mineral waters, radioactive elements, geochronology, geochemistry of ore deposits and carbonaceous deposits and geochemical prospecting. Prior to the Symposium, on July 20 and 21, eight members of the Commission on Geochemistry met and discussed current business and plans for the future. A joint meeting of the Commission with representatives of the Geochemical Society and the Geochemical Societies of France and Japan was also held.

The present composition of the Commission on Geochemistry is as follows: *President*, T. F. W. Barth (Oslo); *Vice-President*, C. W. Correns (Göttingen); *Secretary*, K. Rankama (Helsinki); *Other Members*, H. S. Brown (Pasadena), C. Burri (Zurich), M. Fleischer (Washington, D.C.), S. I. Tomkeieff (Newcastle upon Tyne), H. C. Urey (Chicago), L. R. Wager (Oxford) and F. E. Wickman (Stockholm); *Previously elected observer*, G. Carobbi (Florence); *Newly elected observers* (pending approval by the Union), L. H. Ahrens (Cape Town), C. G. Du Plessis

(Cape Town), A. B. Edwards (Melbourne), G. E. Hutchinson (New Haven, Conn.), E. Ingerson (Washington, D.C.), J. Orcel (Paris), N. W. Rakestraw (La Jolla, Cal.), C. G. Rossby (Stockholm), W. W. Rubey (Washington, D.C.), H. E. Suess (La Jolla, Cal.), K. Sugawara (Nagoya), H. G. Thode (Hamilton, Ontario), S. Tsuboi (Tokyo), A. P. Vinogradov (Moscow).

Nature Conservation

The sixth technical meeting of the International Union for the Conservation of Nature and Natural Resources was held in Edinburgh during June 20–28. Previous accounts of the meeting have directed attention to the increasing importance of the Union as the 'World Parliament of Nature', the aims of which are to conserve renewable natural resources and areas of outstanding natural interest and to protect flora and fauna having scientific, historic or æsthetic significance (*Nature*, 178, 175; 1956). The Proceedings of the Edinburgh conference have now been published and includes full texts or summaries of most of the papers submitted together with the relevant discussions. To reduce the size of the Proceedings, the Société Nationale d'Acclimatation de France (57 rue Cuvier, Paris, 5e) has published a full account of the papers and discussion relating to the biological consequences of myxomatosis. Copies of the Proceedings may be obtained from the Nature Conservancy, 19 Belgrave Square, London, S.W.1, 25*s*.

Serengeti National Park, Tanganyika

Proposals to partition the Serengeti National Park, Tanganyika, were first published in January 1956. Although these were reluctantly accepted by the Trustees of the Park, they were immediately opposed by the Tanganyika and Kenya wild-life societies, as well as by organizations in other countries. One of these was the Fauna Preservation Society, which later arranged for an ecological survey of the area to be carried out. This has now been done by Prof. W. H. Pearsall; details of his report and recommendations have been accepted by the Society and form the bulk of a recent issue of *Oryx* (4, No. 2; August 1957). Prof. Pearsall recommends that a national park, primarily for game preservation, be maintained in the central and western Serengeti, including the Moru area; that a national park for game, indigenous forest and water conservation be maintained in the Crater Highlands; that a connecting corridor with limited human access will be necessary between Ngorongoro Crater and the central plains, if the Ngorongoro Crater Camp is to be maintained as a tourist attraction; that arrangements be made for the early exclusion of pastoral occupation from the national parks; that systematic attempts be made to develop the Masai-occupied territories, particularly in regard to water (conservation and distribution) and grassland and range management; and that a research unit be set up to study the problems of game and habitat conservation. These recommendations have been submitted by the Society to a committee which has been set up by the Tanganyika Government to consider the Serengeti.

Phytopharmacy

A report has been issued of the eighth Annual Symposium of Phytopharmacy (*Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent*, 21, No. 3; 1956. Pp. ii+293–642. Gent: Rijkslandbouwhogeschool, 1956). It contains articles of special interest on insecticides, fungicides, herbicides, nematicides, etc., and related topics, for example, toxicology of organic phosphorus insecticides. There are also contributions on topics of a more general character, for example, the present state of research on fungicides, and a discussion on the postulates, or canons, of Koch in their application to the problems of nematology. The control of insect pests in foodstuffs (for example, oat flakes in packets), by high-frequency electrical fields, is yet another subject on which some interesting and important information has been obtained. This procedure appears to have been successful, the commodity suffering no detectable alteration. The multi-resistance of the common house-fly, induced by selection with insecticides, is described and the probable mechanisms involved discussed in some detail. Several factors which may influence the occurrence of spray damage, that is, after the application of insecticidal or fungicidal sprays, are reviewed, and it is noted that many varieties of fruit trees show very considerable differences in susceptibility during the growing season, and that the greatest damage is sustained during the period of vigorous growth, in particular, immediately after flowering. It has been found that the penetration of a fungicide into a leaf, with consequential damage, may be promoted when the fungicide is mixed with an insecticide in which organic solvents are present. The present status of griseofulvin for the protection of plants has also been considered, the research findings to date being generally, and sometimes very, encouraging.

Sulphonylureas in Experimental and Clinical Diabetes

The sulphonylureas reduce the level of the blood sugar apparently by stimulating the production of insulin by the pancreas. They also increase the effectiveness of injected insulin. These drugs are active when given by mouth and seem to offer the possibility of an alternative to injections of insulin in the treatment of some forms of diabetes mellitus. Control of the diet is still necessary, and some, at any rate, of the derivatives produce harmful side-reactions. In February, the New York Academy of Sciences held a conference on the effects of the sulphonylureas and related compounds in experimental and clinical diabetes (*Annals N.Y. Acad. Sci.*, 71, 1; 1957), during which thirty-two papers were presented. Prof. B. A. Houssay was among the contributors, and the papers dealt both with the scientific and clinical aspects of the action of the drugs.

Properties of Materials at High Rates of Strain

The deformation of solids is a wide and fascinating subject, of interest especially to engineers, metallurgists and physicists. In particular, behaviour when the deformation is rapid is important in various ways. This aspect is being studied in a number of laboratories, and at the suggestion of the Scientific Advisory Council of the Ministry of Supply, the Institution of Mechanical Engineers held in London during April 30–May 2 a conference on "Properties of Materials at High Rates of Strain", which was apparently the first ever held on the subject. A rate of strain greater than about one per second was arbitrarily decided

upon as constituting a high rate, but this figure was not intended to be binding. The opening lecture was given by Dr. A. H. Cottrell, who dealt with some fundamental principles. The detailed papers were classified under the following headings: experimental techniques; metal working; impulse loading and stress waves; non-metallic materials; and basic properties. The matter presented forms a comprehensive, useful and interesting account of the subject. Synopses of the papers are given in the programme of the conference, and advance copies of the papers are available from the Institution of Mechanical Engineers. Ultimately, bound and indexed volumes of the proceedings, including the discussions, will be published.

National Museums of Southern Rhodesia

THE annual report for 1956 of the National Museums of Southern Rhodesia (Pp. 21. Bulawayo: National Museums of Southern Rhodesia. n.p.) records that although plans for a new building for the National Museum in Bulawayo were completed during the year, owing to the suggestion that the building would be better sited in North Park, further developments have been suspended while discussions continue. The Trustees favour the North Park site. At Salisbury a new building is urgently required for the Queen Victoria Museum. In the meanwhile, under the new curator, Col. H. L. Boultbee, some of the galleries have been modernized and every effort has been made to gain the interest and support of the public. Certain limitations are imposed by lack of staff and accommodation, but the Museum is compensating for these handicaps by its activities in other directions, such as the formation of the 'Friends of the Museum', a vigorous schools service and lectures by the staff to many cognate organizations.

Commonwealth Fund Fellowships for Advanced Study and Travel in the United States

A NUMBER of Commonwealth Fund Fellowships are again being offered by the Commonwealth Fund, New York, to British subjects for study and travel in the United States. All expenses of study, travel and living will be met, with some adjustment of stipend for married men. The fellowships, which are open to British men or women who have not previously worked for more than a few months in the United States, are in six categories: *General*, twenty fellowships to graduates of a university in Great Britain or Northern Ireland; candidates must be available in London for interview in March 1958; age, 23–32; tenure, 12–21 months; applications by December 16. *Home Civil Service*, five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades; age, preferably less than 40; tenure, 9–15 months; applications by December 10 to the Treasury. *Australian and New Zealand Civil Services*, five fellowships to Civil servants in the Governments of Australia and New Zealand; age, less than 40; tenure, 9–15 months; applications by November 1 to Dr. H. Carlyle Forster, Box 4079, Melbourne, or the Public Service Commission, Wellington, N.Z., respectively. *Oversea Civil Service*, two fellowships to Civil servants in the Governments of British Colonies, Protectorates and Trust Territories; age, less than 40; tenure, 9–15 months; applications by November 17 to the Colonial Office, London. *Journalism*, three fellowships to journalists, practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession; age, 23–35; tenure, 9–15 months; applications by December 31. *American Studies*, four fellowships to faculty members appointed to or holding posts in American studies in universities in the United Kingdom; candidates to be nominated by their universities; tenure, 4–15 months. Application forms and further information may be obtained through British universities or through Government departments, or from The Warden, Harkness House, 35 Portman Square, London, W.1.

The Corday-Morgan Commonwealth Fellowship

THE Chemical Society invites applications from citizens of any country within the British Commonwealth for the Corday-Morgan Commonwealth Fellowship, to be awarded for post-doctorate (or equivalent) study in any branch of chemistry. It will be tenable for one year in some part of the British Commonwealth other than that in which the candidate received his scientific education, at any university, research institution or other place of study approved by the Corday-Morgan Memorial Fund Executive. The value of the Fellowship will be £700 per annum, but additional allowances may be granted in appropriate cases for travel, university fees, etc. The appointment will date from October 1, 1958, or such other date as may be arranged. Application forms may be obtained from the Secretary, Corday-Morgan Memorial Fund Executive, c/o Chemical Society, Burlington House, London, W.1. Applications must be received by the Secretary not later than March 1, 1958.

University News: Bristol

DR. H. G. H. KEARNS, at present reader in entomology in the University, has been appointed director of the Long Ashton Research Station and to a professorship in the University.

Khartoum

THE following appointments have recently been announced: Dr. J. B. Lynch, lecturer in pathology, University of Liverpool, to the chair of pathology; Mr. Donald Portway, lately Master of St. Catharine's College, Cambridge, to the chair of mechanical engineering.

Announcements

PROF. T. A. BENNET-CLARK, professor of botany in the University of London (King's College), and Prof. E. G. Cox, professor of inorganic and structural chemistry in the University of Leeds, have been appointed to fill vacancies in the membership of the Agricultural Research Council caused by the retirement of Prof. E. J. Maskell and Prof. L. P. Pugh. Prof. P. B. Medawar has been re-appointed for a further term.

A COURSE of six lectures on "The Technique of Technical Writing" will be given at the Borough Polytechnic, Borough Road, London, S.E.1, on Fridays at 2.30 p.m. beginning on October 11, by G. Parr, technical director of Chapman and Hall, Ltd. The fee for the course is ten shillings. Further details may be obtained from the Secretary of the Polytechnic.

ROYAL GREENWICH OBSERVATORY

REPORT FOR 1956–57

THE annual report of the Astronomer Royal for the period April 1, 1956–March 31, 1957*, includes Greenwich and Abinger, Herstmonceux, and Hartland in the section on "Grounds and Buildings". The grounds and buildings at Greenwich and Abinger have not been completely vacated, and under the section devoted to Herstmonceux it is announced that the equatorial group has not yet been handed over to the Royal Greenwich Observatory, but parts of the telescopes have been installed in certain domes. The aluminizing plant, set up in the equatorial group, has been used satisfactorily. The West Block has not been handed over to the Royal Greenwich Observatory, but by special arrangement quartz clocks have been installed. On October 5, 1956, the buildings of the Royal Greenwich Observatory at Hartland were officially handed over.

The Cooke transit circle has been brought into regular use: an electronic automatic punching chronograph has been made and is ready for installation in the transit circle pavilion. The Yapp 36-in. reflector was dismounted and brought from Greenwich to Herstmonceux, and the polar axis has been erected on site, the remainder of the telescope being in store at Herstmonceux. The mirror, which was refigured and aluminized by Sir Howard Grubb, Parsons and Co., is stored at Herstmonceux. The 30-in. reflector, which was formerly mounted on the axis of the 26-in. refractor, has been refigured by Messrs. Cox, Hargreaves and Thomson and afterwards aluminized at Herstmonceux, and has been erected in Dome *A* in the equatorial group. A new polar axis and fork were made for it by the same firm, and it is now ready for test. The Isaac Roberts reflector, acquired on loan from the Science Museum, has been set up in Dome *C*, and its erection is practically complete. The astrographic refractor, 26-in. refractor and the 28-in. refractor have been dismantled and are in store at Herstmonceux.

In the section on astronomical observations, reference is made to the Cooke reversible transit circle, with which 886 transits have been observed since November 28, and the reductions are complete to February 20. A total of 333 stellar plates, containing the images of four or more stars, together with the associated chronograph plates, were obtained with the photographic zenith tube. All these plates have been measured and the data from the stellar plates have been punched on to Hollerith cards. Photographs of the Sun in white light with the photoheliograph, and in Hα light with the birefringent filter, were taken throughout the year. Solar activity continued to rise steeply until November 1956, when the Zurich sunspot number for the month was as high as that for any month of the previous sunspot cycles. During the year, 118 solar flares were observed at Herstmonceux, which was a little more than in any previous similar period. Ionospheric recordings (atmospherics) showed frequent solar flare sudden enhancements. Ionospheric fade-out effects were shown directly from a Paris transmitter by means of a monitor of signal strength, and the information thus given differed somewhat from that provided by the sudden enhancement record.

The Astrometry Department was transferred to Herstmonceux at the end of May and in the short interval before that five plates of the minor planet Vesta and twelve of other minor planets were obtained. Measurement and reduction of these and earlier plates have continued. Searching tests have been made on plates taken with the 17/24-in. Cambridge Schmidt telescope with the object of determining their suitability for astronomy, and as a result of these it appears that straight Schmidt optics, combined with a suitable mechanical design, might well yield a telescope capable of astrometric use.

Among other branches reference may be made to the Cosmic Ray Department, the equipment for which has been largely completed, and the Department is in full operation. The Electronics Laboratory is now at Herstmonceux, and the department has been augmented by the electronics staff of the Time Department at Abinger, Greenwich and Herstmonceux. At Abinger Magnetic Observatory routine work has been carried on by a junior member, assisted occasionally by senior members of the staff from Herstmonceux, following the retirement of the officer-in-charge and the transfer of two of the staff of the magnetic staff to Hartland. In addition to the routine publications of H.M. Nautical Almanac Office, there has been published a new edition of "Interpolation and Allied Tables", the general scope of which is similar to the original edition of 1936, but it has been greatly expanded in content, and in three months 2,000 copies were sold—an indication of the needs that it fills. The Office still continues its work for the Hydrographic Department, that is, the calculation of the data required for the plotting on charts of the Decca navigational lattices. The astrograph, which is designed to simplify astronomical navigation in the air by the projection of precalculated star curves, is being brought back into service, and the Office has calculated new curves for a conventional astrograph and also for an experimental modified model of its own design. As mentioned in the previous year's report, the Office has been investigating the accuracy of astronomical observation at sea, and the overall probable error of a position line turns out to be about 0·8′, but the distribution of error is far from Gaussian, with a preponderance of large values. The most significant feature about the observations is their poor quality; the proportion of 'blunders' is high and the observations from nearly 10 per cent of the observers could not be used.

At the end of the Report there is a short note on the Isaac Newton telescope: so much progress has been made by the Executive Committee towards the production of a design for the telescope that a specification was approved by this Committee and submitted to a firm of instrument makers. Financial approval for placing a specific contract is now being sought.

* Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory. Pp. 12. (Herstmonceux: Royal Greenwich Observatory, 1957.)

COLONIAL DEVELOPMENT AND WELFARE SCHEMES

REPORT FOR 1956–57

THE schemes made under the Colonial Development and Welfare Acts in the period April 1, 1956–March 31, 1957, which are detailed in the latest return*, bring the total commitments for development and welfare under those Acts to £170,452,589, and for research schemes to £16,874,215, of which £23,755,193 and £2,202,880, respectively, are for the year in question. Of this last, £943,301 is for agriculture, £529,979 for medicine, £199,683 for tsetse and trypanosomiasis, £171,128 for insecticides, £103,085 for fisheries, £87,796 for products research, £14,982 for social science, £59,350 for locust control and £10,550 for economics research.

Of the actual research schemes, £166,744 is for the East African Veterinary Research Organization, £229,600 for the East African Agriculture and Forestry Research Organization, £147,229 for the West African Council for Medical Research, £65,169 for the East African Medical Survey and Research Institute, £96,300 for the East African Virus Research Institute, £36,346 for the East African Marine Fisheries Research Organization, £36,711 for the East African Inland Fisheries Research Organization and £28,775 for the East African Institute of Malaria and Vector-Borne Diseases, all for the period 1956–60. The West African Institute for Trypanosomiasis Research received a supplementary £119,050, the Organization for Agricultural Research and Land Use Planning, Tanganyika, £99,616, the East African Trypanosomiasis Research Organization £68,174, the Colonial Pesticides Research Unit, East Africa, £97,150, the Colonial Microbiological Research Institute, Trinidad, £50,104, research into natural products of medical interest at the University College of the West Indies, £33,700, the establishment of a Soils Laboratory, Sarawak, £21,000, physiological and biochemical research in East Africa, £26,478, and research on cotton pests in Nyasaland, £14,487. Agricultural research services in Northern Rhodesia received £52,400 for 1956–58, £41,823 was provided for maintenance of the Colonial Section, Building Research Station (Department of Scientific and Industrial Research), and £15,308 for fundamental insecticides research at the Silwood Park Field Station of the Imperial College of Science and Technology. For the period 1956–60, £18,914 was provided to augment the staff at the Long Ashton Research Station; £79,473 for the Agricultural Research and Experimental Station, Lilongwe, Nyasaland; £60,000 to maintain the Medical Research Council's Field Station, Fajara, Gambia; £40,815 for the agricultural research section of the Abyan Development Programme, Aden; £50,500 for maintenance of the Experimental Rice Station, Federation of Malaya; and £30,550 for maintenance of the Livestock Experimental Station, Ebini, British Guiana.

The development and welfare schemes include a number of large schemes for the development of roads; for example, £1,800,000 for trunk roads in Nigeria, and £3,450,000 for the development of class *B* trunk roads in the Northern Region there, £486,080 for road construction and improvements in North Borneo, and £297,750 for road construction in Fiji; and also for the development of water supplies, such as £1,300,000 for rural water supplies in Northern Nigeria and £100,000 for minor water supplies in rural areas in Jamaica. Major schemes of particular scientific interest include besides a further £555,000 for the central organization for the Colonial Geodetic and Topographical Survey, and £101,500 for the Central Directorate, Colonial Geological Surveys, £108,840 for the geological survey in the Bechuanaland Protectorate, £359,385 for expansion of the geological survey, British Guiana, and £115,180 for the geological survey, Jamaica, £294,750 for cacao expansion, Jamaica, £1,200,000 for African agricultural development in Kenya, £56,550 for leprosy control in Eastern Nigeria, and £120,000 for agricultural research and land use planning, Tanganyika. Among many schemes for educational development may be mentioned the £190,000 for a new hall of residence, £125,850 for senior staff housing, and £111,800 for extensions to the medical school, all at the University College of East Africa; £100,000 for the men's hall of residence and subordinate staff quarters, Royal Technical College, Nairobi; a further £168,000 for permanent buildings and equipment for the University College of Rhodesia and Nyasaland; a supplementary £516,000 for permanent buildings for the University of Malaya; and, to the University College of the West Indies and the associated teaching hospital, £205,255 for a fourth hall of residence, £137,500 for extension of science schools, and £100,000 for staff houses.

* Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development Acts by the Secretary of State for the Colonies, with the concurrence of the Treasury, in the period from 1st April, 1956, to 31st March, 1957. Pp. 40. (London: H.M. Stationery Office, 1957.) 2*s*. 3*d*. net.

BRITISH NATIONAL FOOD SURVEY

THE preface of the sixth annual report of the National Food Survey Committee, which has recently been published*, states that the series "was introduced in 1950 with the object of providing continuous information on the trends of domestic food consumption, expenditure and nutrition in Great Britain". A few minor modifications in technique have been made in the course of the six years but, broadly, the recording and the analysis follow the same pattern and involve visits to about twenty thousand homes (20,400 in 1954; 18,580 in 1955) and the analysis of more than ten thousand completed records. The cost of the survey in both time and money must be very considerable and it seems pertinent to ask if the results are commensurate in value with the outlay.

Any government interested in maintaining the health of the people at a high level must seek to prevent the occurrence of malnutrition even in the mildest degree, and to do this requires to know the composition of the diet currently consumed. The Survey reports are not published until some eighteen months after the end of the year in which the data are collected, but it may be that the results are available to the Ministry itself in time for action to be taken if any marked fall in nutritive value of the diets

* Ministry of Agriculture, Fisheries and Food. Domestic Food Consumption and Expenditure 1955: Annual Report of the National Food Survey Committee. Pp. iv+148. (London: H.M. Stationery Office, 1957.) 6*s*. 6*d*. net.

should become apparent. If this is not so, the most valuable aspect of the survey—that of giving warning of 'incipient malnutrition'—is being entirely lost. If the survey is being used for this purpose, the next important question is how much reliance can be placed upon the evidence so provided.

The report states that "in 1955 no sub-group fell below 95 per cent (of the estimated requirements) in energy value, but percentages less than 95 were recorded in certain sub-groups for protein, calcium, iron and riboflavin". As the figures represent averages for groups of families, it must be supposed that some families within the groups had intakes considerably below the average 95 per cent. Did such families show any evidence of a deficiency of these particular nutrients? This is apparently not known. For young childless couples in the highest income group the energy value of the recorded diet was 143 per cent and the protein content 150 per cent of the recommended allowances; fat intakes were of the order of 150 grams per head per day. Are these people suffering from their over-indulgence, or should these levels be taken as evidence of incipient malnutrition? At the moment, no one seems to know. For the whole ten thousand families, the caloric value of the diet averaged 105 per cent of the estimated requirement. If food intakes are regularly greater than requirements, body-weights in Great Britain should be steadily increasing. If they are not doing so, then either the estimate of requirements is too low or the assessment of the diet is inaccurate.

It is sometimes forgotten that these records deal only with the quantities of food bought for domestic consumption in the course of the survey week; they do not set out to measure the actual quantity of food eaten by the families concerned. In attempting to assess the adequacy of the diets, arbitrary allowances are made for preparation waste, and a round ten per cent deduction is made for edible material discarded or given to pet animals; meals out are given a 'points' value of breakfast 4, dinner 5, tea 3, and supper 2. It is unlikely that these 'corrections' are equally suitable for all families, all seasons, and all geographical areas. No attempt is made to allow for sweets, alcoholic or soft drinks, ice-creams, etc., nor are changes in larder stocks recorded—as they were when the survey first began. The arbitrary allowances made for cooking losses of thiamine and ascorbic acid, and the low vitamin A value assigned to carotene-rich foods are 'corrections' of questionable value. In all, there is room for a quite considerable degree of error when the analysis is confined to small sub-groups, though the broad general picture obtained may be true enough.

The yardstick against which the recorded diets are measured for adequacy is the set of allowances recommended by a Committee of the British Medical Association in 1950 [1]; but in making these recommendations the Committee continually reiterated the 'urgent need' for further extensive study of human nutritional requirements. The failure to parallel the Food Survey with a clinical survey to assess the nutritional state of the consumers of diets of different level means that a most valuable opportunity to forward our knowledge of dietary needs is being entirely missed. As it stands, the Survey provides a mass of interesting detail on price trends, dietary patterns, seasonal, occupational and geographical influences, the effect of family size within different income groups, etc.; but it fails to make any contribution to the knowledge most urgently needed, which relates to what type of diet is best and to what the range of nutrient intake is within which good health can be maintained.

At any time, a food consumption study is of little practical value unless it is made in conjunction with a study of the resultant health of the consumers; at the present time, when such fundamental changes are being introduced into the methods of producing and processing our everyday foods, this second study is of paramount importance and it is to be hoped that future reports will include a section on the nutritional state of the families eating the diets described in so much detail.

M. W. Grant

[1] Report of the Committee on Nutrition. British Medical Association (1950).

RESEARCH ON ROADS IN BRITAIN

THE annual reports of the Road Research Board of the Department of Scientific and Industrial Research and the Director of Road Research for the year 1956 have now appeared*.

The report of the Road Research Board directs attention to the growing road traffic problem and states that a method of evaluating road projects in relation to their economic advantages is to be tried. The importance of training road engineers in traffic engineering and the value of 'before and after' studies with the current road-building programme are emphasized. It is believed that the economic advantages of building new roads have been grossly under-estimated hitherto.

It is suggested that improvement of the facilities for studying the causes and means of reducing accidents is urgent. Closer attention should be paid to the contribution of high speed to the increase in road casualties, because "it may well be that neither the skill of the average driver nor the care normally bestowed on the maintenance of cars is commensurate with their high performance".

The report of the Director of Road Research summarizes the activities of the Road Research Laboratory during 1956; these come mainly under three headings: safety, traffic and materials and methods of construction.

Work on road safety has included tests and recommendations on protective helmets for motor-cyclists. Accident studies have been made with the object of designing safety devices for vehicles, such as interior padding and safety belts. The contribution of the nature of road surfaces to skidding accidents has been investigated; it is estimated that the reduction of accidents due to treating road surfaces at dangerous sites represents a saving of ten times the cost of maintaining the surface with a high resistance to skidding. Statistics of accidents due to various causes have been compiled and are summarized in the report. Vehicle- and road-lighting studies have been made with the object of finding economical methods of reducing accidents due to conditions of night driving.

Traffic statistics are being compiled annually, and detailed surveys of traffic in selected areas are made.

* Road Research 1956: The Report of the Road Research Board with the Report of the Director of Road Research. Pp. iv+88+8 plates. (H.M. Stationery Office, London, 1957.) 5s. 6d. net.

Statistics indicate that in rural areas the average speed of traffic is increasing annually by approximately 1 m.p.h., and during 1956 the average speed of private motor-cars under normal conditions was between 45 and 50 m.p.h., goods vehicles being some 5–10 m.p.h. slower. Economic studies of road improvements are an important feature of the work of the laboratory on the traffic problem.

The section on materials and methods of construction contains accounts of experiments on alternative types of road construction, including foundation aspects such as soil moisture and drainage, soil compaction and soil stabilization. Experiments on concrete have been carried out in connexion with the behaviour of high-strength road surfaces: the mechanism of the cracking of concrete and means of achieving a reduced modulus of elasticity without reduced strength, to lessen the liability to cracking, have been investigated. The use of prestressed concrete for road construction has also been investigated. For this to be feasible, the friction between the foundations and the necessarily long concrete slabs must be such that stresses due to thermal effects are not excessive; the difficulty of achieving this has not yet been overcome. Investigations into the properties and behaviour of bituminous road materials have been carried out with particular reference to anti-skid properties and durability.

Miscellaneous investigations have included the use of radioactive techniques for measuring the density of concrete slabs and the moisture content of soil *in situ*.

Salient features of some full-scale road experiments are given in an appendix. T. M. CHARLTON

A SOLAR 'BLOW-OFF' PROMINENCE

THE solar 'blow-off' prominence of May 18, 1956, and its possible effects are described by Dr. M. A. Ellison in two recent papers (*Mon. Not. Roy. Astro. Soc.*, 116, 6; 1956, and *The Observatory*, 77, 896; 1957). This prominence was one of a number generated during February–April 1956 in the highly active centres of the northern solar hemisphere, and it had been followed across the Sun's disk as a typical quiescent dark filament before it blew-off at the west limb on May 18. The observations relating to this blow-off prominence were made with the combined spectroheliosccope and spectrograph and are discussed in the *Monthly Notices*. A height diagram plotted from measurements made at Edinburgh and Meudon (the latter were supplied by L. d'Azambuja from spectroheliograms) shows the rapid outward acceleration, and before 15h. 00m. the outward velocity along the solar radius was 20 km./sec.; after 16h. 07m. it exceeded 600 km./sec. Calibrated plates of the Hα line were taken at 16h. 01m. and 16h. 04m. with the slit of the spectrograph crossing the arch at a mean height of 88×10^3 km. above the limb. The plates were calibrated immediately afterwards in the spectral light from the centre of the solar disk, thus providing means of deducing the Hα brightness of the various points of the prominence which were traversed by the slit. These are tabulated as fractions of the centre of the disk continuum at a wave-length 15 A. outside the Fraunhofer Hα line. The Doppler shifts on these plates gave components of velocity in the line of sight ranging between − 120 km./sec. in the northern leg and + 360 km./sec. in the southern leg.

Among other points dealt with in the paper, reference may be made to the study of the profiles of the Balmer lines at Edinburgh, which indicated a kinetic temperature for the filaments of 10,000°–15,000° K., and are consequently cool regions embedded in the corona itself at a temperature of 10^6 °K. It has been suggested by F. Hoyle that the higher density and lower temperature in the filaments are maintained by a local magnetic field, which compresses the hot material and cools it sufficiently for the hydrogen atoms to radiate in the Balmer lines. If this occurs, then there must be a great release of magnetic energy during the 2-hr. blow-off phase, and it is extremely improbable that the same material which has blown away into space should return precisely to its original site. In conclusion, Dr. Ellison suggests that such high-speed projection of prominence material may well be associated with the generation of radio-waves of frequencies appropriate to the various levels. There is also the possibility of geomagnetic effects occurring on the Earth after a suitable travel-time in those cases where the blow-off occurs near the centre of the solar disk. It is therefore desirable that all blow-off filaments should be recorded and classified at solar observatories during the International Geophysical Year. A simple scheme of classification has been proposed by Ohman, for inclusion in the Geophysical Year *Solar Patrol Forms*, and the hope is expressed that this classification will be generally adopted.

BROOKHAVEN NATIONAL LABORATORY

THE Brookhaven National Laboratory, which is located at Upton, Long Island, about seventy miles east of New York City, was established in 1947 and is operated by a private institution, Associated Universities, Inc., under contract with the United States Atomic Energy Commission. The board of trustees comprises one scientist and one administrator from each of the nine sponsoring universities—Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Princeton, Pennsylvania, Rochester and Yale. The director of the Laboratory is Dr. L. J. Haworth. The issue of *Atoms for Peace Digest* for June 15 (3, No. 1; 1957), the first of several numbers to be devoted to the description of the large American atomic research centres, deals with the work of Brookhaven National Laboratory. Later issues will deal with Oak Ridge, Argonne, and the smaller research establishments of the U.S. Atomic Energy Commission.

Research and development work at Brookhaven is carried out by eight major scientific departments, including the departments of physics, chemistry and biology and medicine. The cosmotron department is now operating the 'Cosmotron' particle accelerator in three shifts, five days a week, and the main study is that of the unstable particles, including heavy mesons and hyperons. An efficient method for the extraction from the 'Cosmotron' of an intense proton beam and its direction on to a liquid-hydrogen target placed outside the accelerator has been developed. The construction of a proton synchrotron was commenced in 1954; it will consist of a steel and copper

hoop, 842 ft. in diameter, and will use the new 'strong focusing' principle of accelerator design to accelerate protons to energies of 25,000 MeV. The Brookhaven research reactor, completed in 1950, operates at 30 megawatts, and is a natural uranium, graphite-moderated, air-cooled reactor. It is used for many types of experiments in nuclear research, including a large number of simultaneous experiments involving neutrons and also for the production of radioisotopes. The nuclear engineering department is continuing to contribute to the general development of a liquid-metal fuel reactor and is collaborating closely with Messrs. Babcock and Wilcox, who are responsible for the engineering aspects of the design, fabrication and operation of a liquid-fuel reactor experiment for the U.S. Atomic Energy Commission. The experiment is based on research work done at the Laboratory on the concept of a reactor using uranium fuel dissolved in molten bismuth.

Brookhaven was the first institution in the United States to establish a hospital devoted primarily to research in the use of atomic energy for the diagnosis and treatment of disease. The hospital has 115 beds and treats 'terminal cases', that is, persons suffering from an incurable disease, usually some form of cancer. A new Medical Research Centre is being built which will house a forty-eight-bed research hospital, an industrial medical branch and research departments in medical physics, pathology, microbiology, biochemistry and physiology. The Centre will have the first nuclear reactor designed specifically for medical research and therapy and will be capable of producing a beam of neutrons about fifty times as powerful as the beam from Brookhaven's present general research reactor.

PASTEUR INSTITUTE OF SOUTHERN INDIA

THE brilliant research of Louis Pasteur in the 1880–90 decade not only established bacteriology as a science but also revolutionized the practice of medicine by the introduction of therapeutically and often dramatically effective sera and vaccines. Public recognition of the value to humanity of this new science led to the establishment of, in the words of Pasteur, "those sacred dwellings meaningly described as *laboratories*" through funds provided by, to use the modern idiom, voluntary agencies. To quote the names of a few such laboratories of world-wide repute is to put into perspective the Pasteur Institute of Southern India, this year celebrating the golden jubilee of its foundation in 1907; Pasteur Institute of Paris, founded in 1890; Institute of Infective Diseases in Berlin (1891); Lister Institute of London (1891); Rockefeller Institute for Medical Research of New York (1901); Haffkine Institute of Bombay (1896); Pasteur Institute at Kasauli, India (1900). The scientific achievements of the Pasteur Institute of Southern India, so delightfully situated in the Nilgiri Hills at Coonoor, were acclaimed in 1952 by its selection as the venue for the World Health Organization Rabies Conference.

In his foreword to a souvenir volume issued to mark the golden jubilee* the present director, Dr. N. Veeraraghavan, pays tribute to the distinguished men who have guided the destinies of the Institute and to the workers to whose unremitting endeavours it owes its position in the scientific world to-day. The directors were: Lieut.-Col. J. W. Cornwall, 1907–26; Lieut.-Col. T. H. Gloster, 1926–28; Lieut.-Col. K. R. K. Iyengar, 1928–38 and 1941–46; Major H. W. Mulligan, 1938–41; Lieut.-Col. M. L. Ahuja, 1946–47. At its inception, the Institute was a non-governmental organization managed by a committee on which a wide variety of interests were represented. The objectives were to make available effective means of preventing the occurrence of rabies, to spread the knowledge of such means among the public and to undertake research work on rabies or any other disease in so far as funds and the qualifications of the staff permitted. Changes in vaccine for rabies and methods of production over the years are briefly described, and especial reference is made to the painstaking record-keeping, instituted by Cornwall and still maintained, of the history of hundreds of patients bitten by rabid animals, but untreated, considered in parallel with the results of treatment of persons bitten by the same animals; this continued investigation is considered to be a unique record. In recent years the present director has tested the effect of hyperimmune antirabies serum, as well as a host of drugs claimed to be of therapeutic value in established cases of hydrophobia.

Among many other subjects of research at the Institute have been the entomological studies of Patton about 1920 which culminated in his well-known two-volume text-book; Iyengar's interest in clinical laboratory practice, which led to the creation of a separate department; Mulligan's preoccupation with problems of immunity in malaria and with protozoon parasites generally; Ahuja's heed for the potency of vaccines and his association with the action of heparin on Russell's viper venom.

The potential for research and expansion available at the Institute to-day is in large measure due to the scientific ability, administrative capacity, sterling character and vision of Col. Cornwall during his twenty years of service as director. To-day the Institute's laboratories co-operate with the World Health Organization in their world-wide studies on rabies, *Q*-fever and international interlaboratory testing of freeze-dried sera from syphilitic and non-syphilitic sources. Dr. I. G. K. Menon, assistant director, is a member of the World Health Organization expert advisory panel on virus diseases and has instituted new inquiries on the respiratory group of viruses, the intestinal group of viruses and on the recombination and mutations phenomena in influenza viruses.

A section of the souvenir volume describes briefly the scientific contributions by the Institute during fifty years on the following subjects: rabies, influenza, *Q*-fever, cholera, typhoid fever, diphtheria, fuso-spirochætosis, serology of syphilis, tropical eosinophilia, malaria, leishmaniasis, venoms and entomology. The last section is the Scientific Report of the Institute for the year 1956 and includes an experimental evaluation of recent advances in anti-rabies treatment, an assessment of the value of 5 per cent simple vaccine in human treatment and studies on the cultivation of the rabies virus *in vitro*.

R. Ford Tredre

* Pasteur Institute of Southern India, Coonoor. Golden Jubilee Souvenir, 1907–1957. Pp. ii+150+24 plates. (Coonoor: Pasteur Institute of Southern India, 1957.)

SOIL MICROBIOLOGY

ANY further advance in our knowledge of the biological events which occur in soil depends upon the development of new techniques to study the activities of soil organisms in various ecological situations. In consequence, a symposium on "Methods of Studying the Microbiology of Soils" was held under the direction of Prof. Paul Simonart at the University Institute of Agronomy, Louvain, Belgium, during June 3–5. The meeting was attended by thirty-nine participants from twelve European countries and was the result of a proposal by Commission III (Soil Biology) made at the Sixth International Congress of Soil Science in Paris, 1956. Each session began with a review of one aspect of the sampling of specific groups of organisms and the determination of their activities in soil, and concluded with detailed discussion of the points raised by the reviewer. The reviewers presented personal views as well as those included in contributions that had been circulated to all participants before the symposium.

In his opening address to the symposium, Prof. Simonart (who took the chair at the first session) welcomed the participants, and then went on to stress the importance of micro-organisms in the maintenance of life on earth. He described the intense interest that was aroused among earlier investigators by the then unique biochemical transformations such as nitrogen fixation and nitrification which certain soil bacteria can bring about. In conclusion, he pointed out that heterotrophic soil microbes are now receiving more attention than they did in the past.

The review paper by Mme. J. Ziemieka (Pulawy, Poland) described how variations in sampling procedure can influence the results of surveys of soil micro-organisms. Mme. J. Golebiowska *et al.* (Pulawy) had made an investigation of the sources of variability of counts of micro-organisms obtained by the dilution plate technique when the plates had been prepared from samples of soil which had received various treatments. The results showed that the number of microbes in soil samples decreased with the duration of the storage period. Variations in treatment had very little influence on the population levels of soils stored for periods of more than one month in either dry or humid conditions or sifted either before or after the storage period. Counts of micro-organisms varied considerably between samples taken from different positions in one field, whereas the variation exhibited by samples taken from the same place at different times of the year was considerably less. It was suggested that soil samples should be investigated immediately after their removal from the field or after storage for a fortnight. Prof. Simonart and Dr. R. Willeman had determined the influence of desiccation on counts of soil bacteria and showed that the moisture content of samples from a waterlogged soil and stored in varying humidity regimes had a considerable influence on counts of bacterial colonies. Counts fell with decreasing moisture content especially when the moisture content was lowered from 100 to 80 per cent saturation, when they fell one thousandfold. Dr. W. G. Harmsen (Groningen) described how the use of a ball mill to homogenize soil samples before the preparation of dilutions gives an increase in the bacterial count because of fragmentation of bacterial colonies but a reduction in the fungal count because of damage to mycelia.

Prof. V. Treccani (Milan) presided at the second session, which began with a general outline given by Prof. E. N. Michoustine (Academy of Sciences, Moscow) of the various methods employed in the U.S.S.R. for determining the biological activity of soils. The potential fertility and classification of Russian soils are assessed with the aid of microbiological analyses. A useful index of potential fertility has been the determination of the ratio of the numbers of soil bacteria which are able to utilize inorganic nitrogen to those which use organic nitrogen as a nitrogen source. Results show that the proportion of soil bacteria which develop on media containing inorganic nitrogen increases with the fertility of the soil. It has also been found that tillage brings about an increase in the proportion of soil bacilli in the total microbial population and that these bacteria are more abundant in warm soils than cold. Drs. A. V. Rybalkina and E. V. Kononenko (U.S.S.R.) described a method to assess the total activity of the soil microflora, in which glass slides covered with thin films of sterile nutrient agar were buried in soil. Prof. A. Imsenecki (Academy of Sciences, Moscow) showed how the elective culture technique has been useful for the isolation of bacteria with specialized nutritional requirements, but its usefulness suffers from several defects and the results are often difficult to interpret. Prof. N. A. Krassilnikov (U.S.S.R.) submitted an account of the microhabitat of species of *Azotobacter* in the soil and rhizosphere, describing also the natural distribution of genetic strains in the soil. An account of the mobilization by micro-organisms of phosphorus contained in certain water-insoluble minerals and the effect of the activity of these organisms on plant growth was given by Dr. G. Laslo (Agricultural Research Institute, Bucharest).

The third session, with Dr. Harmsen in the chair, was devoted to a discussion of methods of counting soil bacteria. Dr. J. Pochon gave a comprehensive review of work carried out at the Department of Soil Microbiology at the Pasteur Institute which has brought about improvements in the methodology of sampling soil bacteria. The microscopic examination of soil suspensions to estimate the total bacterial count has shown that only 1–10 per cent of the organisms counted in soil suspensions develop on counting plates. Drs. J. Augier and J. Pochon have examined the main defects of counting by direct microscopy, among which are the inability of the observer to distinguish with any degree of confidence dead from living bacteria and small inert particles from bacteria. They have made use of the fact that living cells absorb the dye acridine orange and fluoresce green, whereas dead cells and organic matter fluoresce red or red-brown. Soil suspensions prepared with distilled water are generally heterogeneous, but homogeneous suspensions can be obtained by using a 0·1 per cent solution of the dispersing agent sodium pyrophosphate. The choice of medium employed in making the total counts of soil bacteria has to be arbitrary, but Dr. M. A. Chalvignac found that physiological groups isolated by media containing aqueous extracts of soil include ammonifying, denitrifying, proteolytic and amylolytic bacteria. The proportions of these forms isolated by soil extracts were similar to the relative numbers of the different physiological groups isolated

by selective media. Dr. Pochon described different aspects of the use of a quantitative method of measuring the activity of physiological groups of aerobic and anaerobic micro-organisms. Liquid media containing test substrates are dispensed into tubes to which are added a known series of soil dilutions and then incubated (Dr. J. Pochon *et al.*). The tubes are examined daily for the disappearance of the substrate and for the appearance of metabolites. An example of a precise test for cellulolytic activity employing a suspension of cellulose fibres as a test substrate was given by Dr. H. de Barjac. The results can be expressed as the number of organisms per gram of soil or graphically as an activity curve (Dr. D. Lavergne) by employing a new method of calculating results of dilution tube analyses (Drs. J. Augier and D. Lavergne). Thermophilic bacteria are not very abundant in soil, but besides cellulolytic forms, amylolytic, denitrifying and sulphate-reducing thermophils can be isolated from the soil by variations of the dilution tube technique (Dr. J. Lajudie).

Methods of sampling soil fungi were discussed in the penultimate session, which was presided over by J. S. Waid (Nature Conservancy, Great Britain) and began with a paper given by Prof. Simonart, written in collaboration with Prof. O. Verona (Pisa). The review described the important part that fungi play in the carbon and nitrogen cycles and in plant nutrition even though their biochemical activities as a group are more restricted than those of the bacteria. Soil fungi are difficult to count because of their filamentous habit of growth, and during the preparation of soil suspensions mycelia fragment and colony structure are lost. Fungal colonies which develop on sampling plates may have arisen either from active hyphæ or from inactive propagules. Even though many groups of fungi are known to be active in the soil, for example, Basidiomycetes, they may never be seen on isolation plates because they are not selected by the conditions of isolation and culture. Another difficulty is to find a suitable means of expressing fungal activity which truly reflects events which occur in the soil.

J. S. Waid and M. J. Woodman submitted a method of estimating hyphal activity which partially overcomes some of the defects of the Rossi–Cholodny contact slide method. In place of glass slides, nylon gauze is buried in soil and left for several months. Fungal activity is estimated by counting the number of hyphæ per mesh, and the technique reveals differences in activity in contrasting soil types. Dr. D. Parkinson (University of Liverpool) described new methods for the qualitative and quantitative study of fungi in the rhizosphere. A soil box technique has been devised to isolate mycelia active in the rhizosphere of various parts of a root system. A direct method can also be employed to estimate the amount of fungal development in the rhizosphere by preparing slides by a soil impression technique. The results demonstrate the existence of well-defined microfloras in various parts of the rhizosphere at different stages of plant development. A paper by J. S. Waid, C. K. Capstick and D. C. Twinn argued that fungal infections of free-living nematodes can only be accurately estimated with efficient methods of sampling soil nematodes. Using a method with an extraction-rate of 97 per cent it was found that 45 per cent of a sample of nematodes was infected by either saprophytic or predacious fungi, but it is not known how many of the infected nematodes were dead at the time of sampling.

During the final session, which was presided over by Dr. J. Duche (Gif-sur-Yvette, France), the possibility of developing standard methods for sampling soil micro-organisms was criticized by Dr. T. K. Wieringa (Wageningen). While agreeing that microbial, chemical and physical analyses are complementary when determining the economic potentialities of soils, Dr. Wieringa emphasized that the characterization of soils by routine microbiological methods is laborious and limited by practical considerations. He described various ways of measuring soil activity which had not been considered in detail by the symposium, such as the measurement of carbon dioxide production, carbohydrate decomposition, the measurement of mineral deficiencies with microbial growth assays and the effect of adding various substrates to soils such as urea or glutamine.

During the discussion of Dr. Wieringa's paper several participants stated that it is nearly impossible to obtain uniform counts of soil micro-organisms from one sample analysed by separate laboratories, and this fact makes the biological characterization of soils difficult. Dr. Pochon then proposed a scheme by which all participants of the symposium were invited to take part in carrying out a limited number of microbiological analyses and tests of biological activity upon two soil types bearing characteristic vegetation. The results obtained from widely scattered laboratories could then be compared to determine if soils could be characterized by a standard microbiological procedure.

It is a pleasure to record the excellence of the organization and arrangements for the symposium made by the University of Louvain and the International Society of Soil Science. The success of the meeting was due to the good humour, patience and hospitality of Prof. Simonart and his colleagues, under whose supervision the full proceedings of the symposium are now being prepared for publication.

J. S. Waid
D. Parkinson

BIOLOGY OF HAIR GROWTH

A SYMPOSIUM on the biology of hair growth, organized by Prof. W. Montagna (Providence) and Prof. W. S. Bullough (Birkbeck College, London) under the auspices of the British Society for Research on Ageing, was held in London at the Royal College of Surgeons during August 7–9. The symposium secretary was Dr. G. Bourne (St. Bartholomew's Hospital Medical College, London). The very large audience from Europe and the United States was welcomed by Sir Francis Fraser (British Postgraduate Medical Federation, London), and introductory addresses were also given by Prof. Montagna and Prof. S. Rothman (Chicago), who both referred to the great advances made during the past decade in our knowledge of the structure and physiology of mammalian skin.

The first day was devoted to the structure of the hair and the hair follicle. In the opening address Dr. E. Van Scott (Bethesda) dealt with the anatomy of the human hair follicle, describing in particular the changes which occur with age. He was followed by

Prof. Montagna, who discussed the manner in which the undifferentiated matrix cells move upwards to arrange themselves in concentric sheaths prior to their differentiation. Of particular interest was his account of the follicular blood system, and of the way in which it is turned inside out as the follicle passes from anagen to catagen. Dr. O. Braun-Falco (Mainz) then described the distribution of enzyme systems as revealed by histochemical techniques, stressing among other things the evident importance of Krebs cycle and cytochrome enzymes in the active matrix. In the discussion following these papers attention was directed to what proved to be two of the recurrent themes of the symposium, the role of the dermal papilla and the nature of the drastic change in the matrix cells during the onset of anagen. It was suggested by several speakers that these two are probably closely interrelated, the initial stimulus to the growth of a new hair developing in the dermal papilla and spreading from there to the matrix cells. Evidently the dermal papilla contains active enzyme systems during the follicular growth phase, but there is an apparent lack of activity during the follicular resting phase.

The account of follicular structure was continued by Dr. E. H. Mercer (London). With the use of a new embedding medium which allowed excellent sections to be cut at extreme thinness, he was able to show a beautiful series of photographs taken with an electron microscope. He first examined the structure of the undifferentiated matrix cells and the irregular nature of their boundary with the dermal papilla. He then gave details of the intracellular formation of keratin fibrils in those cells destined to form the hair shaft, and showed how such fibrils ultimately filled the dying cells. Those cells destined to be part of the inner root sheath first lay down trichohyaline granules which apparently join together and become fibrous in the region where the sheath itself becomes birefringent. In the more static cells of the outer root sheath the cell membranes were shown to be highly folded. Later discussion ranged over the question as to how far the details described might be artefacts due to the drastic nature of the technique, but Dr. Mercer was confident that his results were reasonably accurate. The day then ended with a detailed account by Dr. G. Matoltsy (New York) of the chemistry of the keratinization of skin, horn, and especially hair.

The second day began with a description by Dr. E. H. Mercer of the biosynthesis of fibres. This was an especially interesting contribution, in that comparisons were made with such other forms of fibre formation as are seen in collagen, in the silk glands of caterpillars, and in the egg-capsule glands of cockroaches. He traced fibre formation from the amino-acid micromolecules, through the precursor macromolecules to the fibrillar macromolecules and the stabilized intracellular aggregations of fibrils. He discussed the alternative possibilities that in fibril formation the polypeptide chains of the precursor macromolecules may open out, or that these macromolecular blocks may fuse together end to end. On the latter alternative, if the blocks are symmetrical a straight fibril should result, but if they are asymmetrical the result should be a helix. After this address, Dr. T. Fitzpatrick (Portland, Oregon) considered the nature of hair pigments. He pointed out that they fall into two chemical groups, the brown-black melanin pigments which are so widespread in Nature and the yellow-red pheomelanin pigments. These two pigment groups are under separate genetic control, and the two metabolic pathways and their interconnexions were described in detail.

Dr. H. Chase (Providence) returned to the question of the various sheaths of cells which form the hair and the inner root sheath. He stressed again the precise way in which the undifferentiated matrix cells orient themselves to form these sheaths, and described elegant experiments by which the matrix cells could be displaced. In those follicles which survived this drastic treatment it was found that the displacement of the matrix cells in no way affected the subsequent formation of the hair, thus showing that the cells are equipotent and that their subsequent differentiation is entirely dependent on the position in which they find themselves. Dr. Chase also introduced the subject of the behaviour of the pigment cells, and this was taken up in more detail in the subsequent paper by Dr. M. S. C. Birbeck (London). Using electron microscopy, he described the structure of the melanocytes on the top of the dermal papilla, gave details of the formation of melanin granules in association with intracellular cytoplasmic lamellæ, and showed how the granules are passed through the cell wall into the adjacent pre-cortical cells.

The attention of the symposium then turned to the physiological aspects of hair formation. Prof. A. Durward (Leeds) began with a stimulating account of the vascularization of follicles. The smaller follicles have no particular blood supply, and capillaries do not even penetrate into the dermal papillæ. The larger follicles, however, are intimately surrounded by a capillary network and their dermal papillæ are well vascularized. In the rat the production of new hairs occurs in waves passing ventrodorsally, and the blood flow was shown to be augmented in regions of rapid hair growth. The paper ended with a consideration of the effects of plucking quiescent hairs. Such treatment activates the follicles, increases the blood flow, and results in the production of new hairs. However, this only happens if a large enough area of hair is plucked, a result which suggests that the plucking of only a few follicles results in too small a stimulus.

The second day ended with a paper by Prof. W. S. Bullough and Dr. Edna B. Laurence (Birkbeck College, London) on the mitotic activity of the follicle. They began with a description of the mitotic pattern in the growing follicle, and of the remarkably high rate of mitosis of the matrix cells. The energy relations of this great mitotic activity were then described, and it was shown by means of *in vitro* studies that cell division is completely dependent on respiration and that it cannot be supported by glycolysis alone. The two most important raw materials are glucose and oxygen and any inhibitor of glycolysis, the Krebs cycle, the cytochrome system, or the processes of energy transfer immediately inhibits mitosis. In the intact mouse the active mitosis of the matrix continues unabated in almost all circumstances, and is only reduced at the point of death through starvation or shock.

The final day of the symposium began with another paper by Dr. Chase, who discussed the possible ways in which a resting follicle may be stimulated to begin a new phase of growth, and who confirmed the point made by Prof. Durward that a certain minimum number of hairs must be plucked before new growth will commence. He added the important information

that in early telogen many more hairs must be plucked to stimulate growth than is necessary in late telogen, a result which suggests the possibility of a slow build-up of some natural stimulator during telogen. He then referred to the effects of radiation, and this subject was taken up in detail by Dr. Van Scott, who described a method of using hair roots as a tool for checking the effects of ionizing radiations on the body.

The nutritional problems of the growing hair were next discussed by Dr. M. L. Ryder (Wool Industries Research Association, Leeds) with special reference to wool. Carbohydrate and protein, but not fat, are evidently critically important, and Dr. Ryder went on to describe the results of experiments on the uptake of radioactive glucose and of radioactive cystine. The former is apparently absorbed predominantly by the hair bulb while the latter appears to enter higher up, just below the region of keratinization. Then followed a lecture by Dr. J. B. Hamilton (New York), who discussed what are evidently genetic differences in the rate of hair growth in Caucasian and Japanese men and women.

The final afternoon began with a review by Dr. M. P. Mohn (New York) of the effects on rat hair growth of the hormones of the gonads, adrenal, pituitary, thyroid, and islets of Langerhans. Inhibitory effects were described with the use of œstrogens, glucocorticoids, adrenalin, and adrenocorticotrophic hormone. Some stimulus was obtained with thyroxin and insulin. Other hormones were without effect. The symposium ended with a description by Dr. R. E. Billingham (University College, London) of the *de novo* formation of follicles in the adult. In disproving the theory that such new formation never occurs, he gave details of follicle production in the rabbit when a large wound is resurfaced with new epidermis, and in the deer during the annual production of new antlers. However, he pointed out that in normal adult mammals there is no evidence that this process ever occurs.

The symposium was clearly a great success and all those connected with its organization are to be highly congratulated. Under the general editorship of Prof. Montagna the various contributions are now to be collected and published in book form, and the result should be an invaluable review of the present state of knowledge of hair growth.

URANIUM, HELIUM AND THE AGES OF METEORITES

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THE recent measurements of the uranium contents of stone[1] and iron[2] meteorites permit a re-examination of the accumulated data on the rare gases present in meteorites with the object of establishing helium ages. These may refer to the time of accumulation of either radiogenic helium[3–7] or helium produced by cosmic rays[8–13]. In this report major emphasis will be on the radiogenic-helium ages of stone meteorites.

The uranium data on four chondrites indicate a constant uranium content of about $1{\cdot}1 \times 10^{-8}$ gm./gm. in such meteorites[1]. Within the accuracy (approximately 10 per cent) of the method used, the isotopic composition of the uranium in stone meteorites[1] appears to be the same as that of terrestrial material. The helium contents of meteorites have been reported by Paneth[3–7], Gerling[14–17], their co-workers, and others[12,13,18,19]. In many of the samples the isotopic composition of the helium has also been measured.

Four generalizations of existing data are necessary to determine ages from helium data. (1) It is assumed that the average uranium content of all chondrites for which no recent determinations have been made is $1{\cdot}1 \times 10^{-8}$ gm./gm. (2) The non-radiogenic helium is assumed to consist of about four helium-4 atoms for each helium-3 atom. The radiogenic helium in stone meteorites can then be estimated if the helium-3 content has been measured. Since the helium-3 contents of stones are usually small, the conclusions from this work are not seriously changed even by doubling the assumed helium-4/helium-3 ratio. (3) It is assumed that the ratios thorium/uranium and uranium-238/uranium-235 in meteorites are the same as those found terrestrially (3·6 and 137·8, respectively). A 30 per cent difference in the thorium–uranium ratio used will affect the calculated ages by about 10 per cent. (4) The rate of production of helium-3 (gm./yr.) from cosmic rays is taken to be $8{\cdot}2 \times 10^{-15}$ c.c. S.T.P. in stone meteorites. This is derived from a value of $5{\cdot}7 \times 10^{-15}$ c.c. S.T.P. helium-3/gm./yr. in iron estimated by Currie, Libby and Wolfgang[20] from their measurements on the formation of tritium by BeV. protons and corrected for the direct production of helium-3. The variation of the cross-section for the formation of tritium as a function of atomic number and the elemental abundances for meteorites used in the calculation are from Currie *et al.*[20] and Suess and Urey[21]. Other values[22,23] that have been used are within a factor of three of that given here. (The tritium–helium-3 data of Begemann, Geiss and Hess[18] give a value in agreement with that used here.)

The stone meteorites for which helium data are available and for which the uranium data are applicable are listed with descriptive information[24] in columns 1, 2 and 3 of Table 1. Columns 4 and 5 give the total helium and the helium-3 contents in 10^{-6} c.c. S.T.P./gm. of meteorite. Column 6 gives data on the uranium content in units of 10^{-8} gm./gm. The

Table 1

Meteorite	Classification	Weight (kgm.)	Total helium[a]	Helium-3[a]	Uranium (10^{-6} gm./gm.)	Radiogenic helium age (10^9 yr.)	Potassium–argon age (10^9 yr.)	Ref.	Helium-3 age (10^9 yr.)
Akaba	White chond.	1	14·2	0·9	0·84[b]	3·2[b]	3·8	26	0·112
Norton County (aubrite)	Olivine-enstatite achond.	1,000	—	2·27	1·0[c]	3·7 —	4·40	27	0·285[d]
Ochansk	Polymict brecciated spher. bronzite chond.	500	15·5	0·15	1·1[e]	4·0	4·50	17[h]	0·0185
Elenovka	'Cryst. chond.'[f]	70[f]	16·1	0·3	,,	4·0	4·00	17	0·037
Saratov	Intermed. (or grey) spher. hypersthene chond.	328	15·3	0·3	,,	3·8	3·80	17	0·035
Bjurbole	Spher. hypersthene chond.	330	15·6	0·15	,,	4·0	3·6 4·32	17 27	0·0185
Khovtneyi Khutov	Intermed. veined chond.	195	17·7	0·4	,,	4·2	3·00	17	0·050
Nuevo Laredo	Olivine-clinohypersthene hypersthene chond.[i]	0·5	13·4	0·038	12·6	0·45	3·1–3·6 (4·52; Pb-Pb)	19 28	0·0047
Holbrook	Crys. spher. hypersthene chond.	240	3·2	0·06	1·4	0·90	4·17 4·40	29 27	0·0075
Alfienella	Intermed. hypersthene chond.	228	4·5	0·48	1·1[e]	0·84	—		0·06
Pervomaiskii poselok	Intermed. veined cryst. enstatite chond.	49							
Black			2·7	—	1·1[e]	0·94	1·8	17	—
Grey			1·9	0·06	,,	0·63	0·64		0·0074
Kunashak Grey	'Cryst. grey chond.'[f] Olivine chond.	200[g]	1·6	0·04	,,	0·55	0·70	17	0·005

(*a*) Helium contents in 10^{-6} c.c. S.T.P./gm.
(*b*) Uranium content and $3·2 \times 10^9$ age reported by Reasbeck and Mayne (ref. 7). The difference in radiogenic helium ages is probably due to the use of different approximations.
(*c*) Tilton, G. R., Ph.D. thesis, University of Chicago (1952).
(*d*) H^3–He^3 measurements give a cosmic-ray age of $0·24–0·28 \times 10^9$ yr. for this meteorite (ref. 13).
(*e*) Uranium content based on average for chondrites by Hamaguchi, Reed and Turkevich (ref. 1).
(*f*) See ref. 17.
(*g*) See ref. 15.
(*h*) The Russian results are summarized in ref. 17.
(*i*) Nuevo Laredo is reported to be a chondritic howardite by Patterson (ref. 28*b*).

calculated radiogenic ages are given in column 7; they lie in the range $0·5–4·5 \times 10^9$ years. Radiogenic ages measured by other workers (column 9) who used primarily the potassium-40–argon-40 method are listed in column 8. In eight cases out of eleven, the radiogenic helium ages agree with these to within 15 per cent. These eight cases of agreement can be added to the weight of evidence from meteorite age determinations[25] against a change of fundamental constants with time. The cosmic-ray ages deduced from the helium-3 content are listed in column 10. They are all significantly lower than the corresponding radiogenic ages and range from a few to about 300 million years.

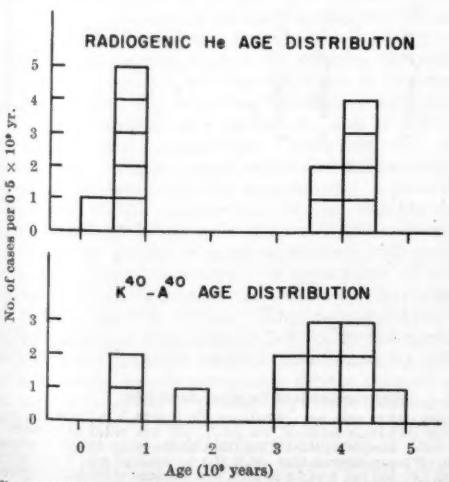

Fig. 1. Distribution of meteorite ages from radiogenic helium and potassium–argon measurements

The radiogenic helium ages for the stone meteorites fall into two distinct groups, one with values up to about 1×10^9 yr., the other with values of about 4×10^9 yr. This segregation is less clear-cut than previous age determinations, although a marked grouping of chondrites at $4–4·5 \times 10^9$ yr. has been emphasized by Geiss and Hess[27]. Fig. 1 shows the distribution in ages of these meteorites as determined by the radiogenic helium (top) and by the potassium–argon methods (bottom).

Two of the stone meteorites (Nuevo Laredo and Holbrook), however, show short ages by the radiogenic helium method, whereas the potassium–argon ages are long. The discrepancy is emphasized by the fact that in these two stones the uranium was actually measured, and in the case of Nuevo Laredo an even longer age ($4·5 \times 10^9$ yr.) is deduced by a third method (lead–lead)[28*a*].

Among the possible explanations for the age grouping presented here is that the $4·5 \times 10^9$ year age measures the accumulation and segregation of all the meteoritic matter, and that some of the material lost its radiogenic helium about 10^9 years ago. This loss of helium was sometimes accompanied by a loss of radiogenic argon. (Reynolds and Lipson (ref. 19) suggest that the lower age for Nuevo Laredo, derived from potassium–argon measurement as against the lead isotope method, is due to severe heating late in the history of the object.) Such an occasion might have been the break-up of a parent body.

The cosmic-ray ages that we deduce from the helium-3 contents of stone meteorites vary from 5 to 300 million years. The recent and more accurate tritium–helium-3 measurement on the Norton County achondrite by Begemann, Geiss and Hess[13] gave a result of 240–280 million years and hence falls near the maximum of our range. Cosmic-ray ages are subject to the usual uncertainties arising from lack

of knowledge of the size and shape of the meteorites before entering the Earth's atmosphere. The fact that the cosmic-ray ages are significantly lower than the corresponding radiogenic ages may be due entirely to the effect of self-shielding in the original meteorite. The possibility that these objects spent most of their time in regions of cosmic-ray intensity lower than that near the Earth must also be considered. However, the evidence would not seem to support the argument that radiogenic helium has been lost preferentially[30] to helium induced by cosmic rays in stone meteorites.

We wish to thank Mr. W. Nichiporuk for supplying translations of most of the Russian work to which we refer, and Dr. R. Marshall and Dr. F. Begemann for many helpful discussions.

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HIGH-VOLTAGE PAPER ELECTROPHORESIS OF INORGANIC CATIONS: ALKALI, ALKALINE-EARTH AND OTHER METALS

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THE importance of the alkali and alkaline-earth metals in biochemistry, nuclear science and industry has prompted suggestions for convenient micro-methods for the detection and estimation of these ions in mixtures or by themselves. Most of the methods recently proposed are based on polarography, flame photometry, chromatography and paper electrophoresis. Flame photometry has been successfully applied to sodium, potassium and calcium, although mutual interference and the presence of other cations and anions can become serious disturbing factors. Both chromatographic and electrophoretic procedures aim at a complete separation of the individual metals as salts, cations or anionic complex compounds. By none of the chromatographic techniques[1] can a satisfactory separation of all the alkali metals be achieved; and paper electrophoretic methods[2], although much quicker and unrestricted with respect to the presence of most anions, are unable to separate potassium, rubidium and cæsium from one another.

By application of a high-voltage technique[3] with its attendant superior resolving power, the rapid, simultaneous separation of all the alkali metals (except ammonium) has been found feasible. As

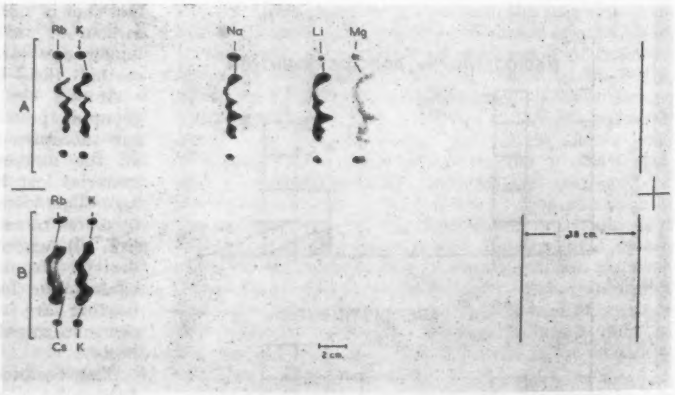

Fig. 1. Electrophoresis of the alkali metal ions

Conditions: (*A*) 100 V./cm., 12 m.amp./cm., Whatman No. 3 *MM*, 4 in. × 22½ in. strip, approx. 0·1 *M* ammonium carbonate solution, 7·9 gm./l., *p*H 8·9, mean temperature of cooling water 9° C., 23 min., sample applied 2 in. from anode end; spraying reagent, 0·01 per cent solution of bromothymol-blue (B.D.H.) in ethanol and water (9:1). (*B*) Same conditions as in (*A*), but run first for 20 min. to a distance of 38 cm., transferred to a new strip and run for another 17 min. to a total distance of 70·1 cm. Distances measured from starting line to leading edge of the rubidium band

Table 1

Cation	Ionic mobility at 18° C. in cm.² V.⁻¹sec.⁻¹	Relative rate of migration (Rb = 1·000)
K^+	64·6	0·962
Rb^+	67·5	1·000
Cs^+	68·0	0·988

shown by Fig. 1 (*A*) the separation of rubidium or cæsium from potassium and the other cations can be achieved in 23 min. at a potential gradient of 100 V./cm., and (*B*) the more difficult separation of rubidium from cæsium and the others requires 37 min. and a migration path of 70·1 cm. Since the effective length of the paper strip under existing experimental conditions is only 50 cm., a transfer method had to be adopted whereby the experiment was interrupted after 20 min., corresponding to a distance of 38 cm. travelled by rubidium, the anode end of the strip rolled back, the cathode end joined to a new strip and the run continued for another 17 min. Although the technique helped to overcome quite satisfactorily the limitations imposed by the dimensions of the available apparatus, for routine separations of mixtures of rubidium, cæsium and potassium an apparatus of a length of 80–100 cm. would be advisable. The relative rates of migration observed do not agree completely with the sequence of the ionic mobilities[4] calculated for free migration at infinite dilution, as Table 1 shows.

The discrepancy, however, is surprisingly small considering the fact that the conditions obtaining in paper electrophoresis, with possible adsorption and other migration-impeding effects, differ significantly from those in free migration at infinite dilution. It is interesting to note that the comparatively small difference of 1·2 per cent in migration-rates between rubidium and cæsium appears to be sufficient for a separation under the conditions described.

The best results were obtained by applying the samples to paper strips moistened with the buffer solution and blotted between two thick layers of filter paper. The choice of a conveniently volatile buffer such as an ammonium carbonate solution makes it possible to free the paper strip from buffer salts after the run by drying it for 10 min. at 80° C. and to locate the cations, presumably as their oxides, by means of a *p*H-indicator solution. Bromothymol blue proved most suitable in this respect by showing the cations with sharp contrast as blue spots on a practically white background, affording thus a sensitivity of 0·2 μgm. of sodium and potassium, and of 0·5 μgm. of lithium and magnesium. Spraying the strip lightly with distilled water before the indicator spray enhanced its sensitivity for magnesium. A procedure based on visual comparison of the sample with suitable standards has proved a rapid and convenient method with results in good agreement with control tests by flame photometry. A separation of potassium, sodium, lithium and magnesium can be obtained in 5 min. at 140 V./cm. The reproducibility of experiments has been greatly helped by the constant and uniform pressure control maintained by means of a basically simple pneumatic device consisting of an inflatable rubber or plastic bag and pressure gauge. Measurements by thermocouples of the temperature in the paper strip during electrophoresis to test the degree of efficiency of cooling have shown that the temperature can be up to several degrees higher than the mean temperature of the cooling water, if the pressure is not kept constant.

For the complete separation of the alkaline-earth metals, a citric acid buffer with its capacity for forming complexes was found most suitable and gave the electrophoretic migration sequences as illustrated in Fig. 2 (*B*). The position of magnesium is different from that reported by Evans and Strain[3] in a similar buffer solution, though not of exactly the same *p*H value; and according to them, magnesium is more anionic than calcium. The alkaline-earth ions were detected by spraying with alizarin *S* and subsequent exposure to ammonia vapour, a general reaction the sensitivity of which is highest for calcium and lowest for magnesium. The position of magnesium was confirmed by spraying magnesium and calcium with 8-hydroxyquinoline, followed by exposure to ammonia vapour[5] and viewing under ultra-violet light, in which magnesium shows a characteristic bright fluorescence.

Fig. 2, *A*, *B* and *C* (photographed under ultra-violet light) show the relative positions of the negatively charged complexes of fourteen cations run

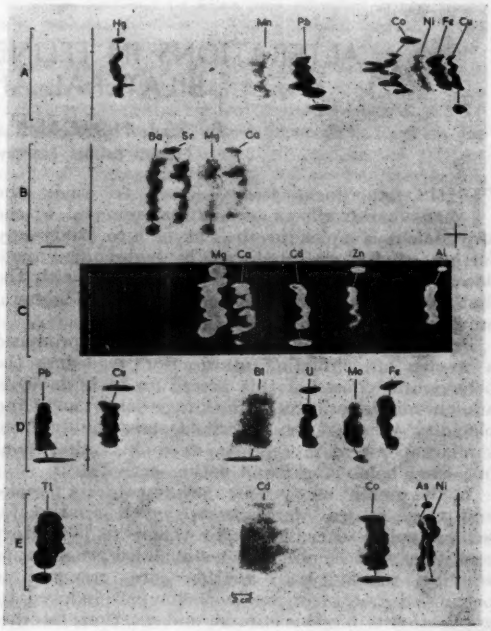

Fig. 2. Electrophoresis of the alkaline-earth metals and other cations

Conditions: (*A*) 100 V./cm., 13m. amp./cm., Whatman No. 3 *MM*, 4 in. × 22½ in. strip, 0·05 *M* citric acid solution adjusted with ammonia solution to *p*H 5·5, mean temperature of cooling water 10° C., 45 min., sample applied 3 in. from cathode end; spraying reagent, dilute ammonium sulphide and sodium peroxide solutions (for manganese)

(*B*) Same as in (*A*); spraying reagent, 0·1 per cent aq. sol. alizarin *S* (B.D.H.) followed by exposure to ammonia vapour.

(*C*) Same as in (*A*); spraying reagent, 8-hydroxyquinoline (B.D.H.) followed by exposure to ammonia vapour

(*D*) 140 V./cm., 6·5 m.amp./cm. Whatman No. 3 *MM*, 4 × 22½ in. strip, 0·05 *M* citric acid solution adjusted to *p*H 3·1, mean temperature of cooling water 11° C., 30 min., sample applied 4½ in. from cathode end; spraying reagent: dilute ammonium sulphide solution for lead, copper and bismuth, potassium ferrocyanide for uranium, molybdenum and iron

(*E*) Same as in (*D*), but sample applied 2 in. from anode end and sprayed with dilute ammonium sulphide solution

at *p*H 5·5 and a potential gradient of 100 V./cm. for 45 min. At *p*H 5·5, Fe^{2+} and Fe^{3+}, Ti^{3+}, UO_2^{2+} and Al^{3+} show a tendency to form at least two complexes of varying degrees of ionization producing on electrophoresis two bands. Only one band of Fe^{3+} is apparent in (*A*), as the faster band had left the strip. This effect, however, can be reduced to an insignificant minimum by decreasing the *p*H value of the buffer solution to 3·1, or 2·5 for Ti^{3+}. At *p*H 2·5 the non-complexed cationic Fe^{2+} can be rapidly separated from Fe^{3+}. Fig. 2 (*D*) and (*E*) show the relative positions of some cations after 30 min. at *p*H 3·1 and 140 V./cm., where uranium, applied either as uranyl nitrate or acetate, gives a particularly sharp band. The position of Mo^{6+} is interesting, since at *p*H 5·5 it is ahead of iron. Bi^{3+}, which migrates at the same rate as cobalt at *p*H 5·5, is well separated from it at *p*H 3·1, at which both bismuth and cadmium give fairly diffuse zones. (*E*) shows that some of the ions migrate as non-complexed cations, among which Tl^{+} shows an outstanding mobility. In addition, a mixture of Sb^{3+}, Sn^{2+}, Cd^{2+} and As^{3+} can be separated at *p*H 5·5, and a mixture of Mo^{6+}, V^{5+} and Ti^{3+} at *p*H 2·9.

The time required, though already short, can be appreciably reduced if similar but simpler mixtures are treated.

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ALTERATIONS IN FELINE BEHAVIOUR FOLLOWING BILATERAL AMYGDALECTOMY

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THIS experiment was designed to study the behavioural effects of bilateral removal of the amygdaloid complex in the cat and to study any further alterations produced by subsequent neodecortication. This article will deal only with the first part of the study, that is, the effects of bilateral amygdalectomy.

Previous studies by several workers have produced a wealth of conflicting information regarding the behavioural effects of this procedure in both acute and chronic experiments. Both rage behaviour[1,2] and placidity[3,4] have been described, presumably from similar operative procedures, as well as alterations in sexual behaviour[3,4] and eating activities[4-6].

In the present study, nine mature cats, six females and three males, were observed and studied for several weeks after their adjustment to laboratory conditions. These observations included general cage activity, reactivity to routine care, response to petting, degree of aggressive behaviour induced by application of noxious stimuli, and reactions to other animals.

Bilateral amygdalectomy was performed in two stages at approximately one-month intervals. The amygdaloid nuclei and pyriform lobes were removed by suction methods after proper exposure of the temporal lobes by means of a trans-temporal trepanation. Recovery in the first post-operative week was supported with antibiotics and fluid therapy, and in most cases by the second week post-operatively spontaneous eating was resumed and recovery thereafter uneventful. Tests similar to those carried out pre-operatively were instituted with particular emphasis being placed on alterations in the pre-operative rage thresholds and responses to pleasurable stimuli, as well as any alterations in sexual behaviour and eating activities.

With the exception of a moderate hyperactivity and hypervocality, both of which persisted for some six weeks after the second operation, general behavioural changes were conspicuously absent. Rage thresholds were not significantly altered from their pre-operative levels as determined by the application of threatening and painful stimuli. No alterations in sexual behaviour were seen, although animals of different sex were frequently placed together. There was no increment in so-called 'pleasure' reactions as previously described by Schreiner and Kling[3] or any noticeable 'taming' as a result of the operative procedure. It was, however, observed that domestic stock cats often become more tractable under laboratory care, and it is pertinent to point out that the assessment of 'docility' or 'placidity' is very difficult in this species. In our experience, several animals of extremely nasty temper became in time well adjusted to their new environment without any operative procedure being performed.

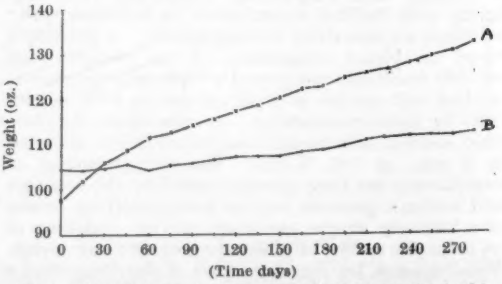

Fig. 1. Weight changes: *A* in amygdalectomized cats (9 animals) from low weights after second operation; *B*, in control cats (7 animals) from initial laboratory weights, over a period of 285 days

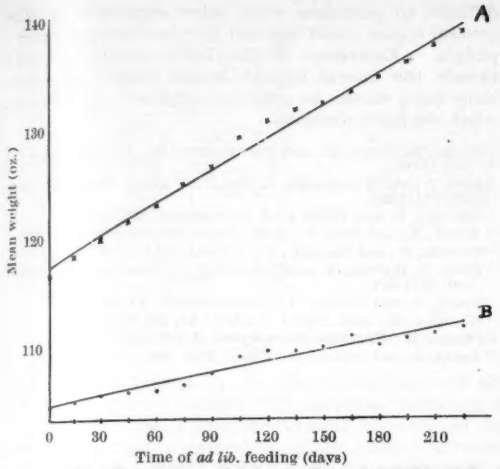

Fig. 2. Regression lines of amygdalectomized and control cats over a 225 day period of *ad libitum* feeding. *A*, amygdalectomies (9 animals); regression line, $Y = 116{\cdot}84 + 1{\cdot}39\ X$; t value for slope = 36·58 ($P < 0{\cdot}001$). *B*, controls (7 animals); regression line, $Y = 105{\cdot}77 + 0{\cdot}469\ X$; t value for slope = 11·96 ($P < 0{\cdot}001$). Differences between slopes, $P < 0{\cdot}01$

Weights were determined on all animals pre-operatively and also at regular intervals in the post-operative period. The one behavioural change that expressed itself in the post-operative period was a definite hyperphagia in all of the amygdalectomized animals. These were compared with four normal cats and three bilaterally decorticate cats serving as controls.

Initially, there was no significant difference in the mean weights of the experimental animals (100·6 oz.) as compared to the control group (104·6 oz.), and there was no significant difference between the two groups serving as controls, these latter, therefore, being grouped as one. Fig. 1 shows weight as a function of time, the weights of the experimental animals being plotted from the low-point after the second operation and all the controls from their initial laboratory weights. Direct group comparison testing showed that the weights of the experimental group were not significantly different from the controls until approximately the 90-day point on the time-scale.

In order to evaluate properly this weight change in the experimental group *ad libitum* feedings were started on all animals, experimental and controls. Following this procedure, the experimental group continued to gain weight at a more significant rate as compared to the controls.

Fig. 2 shows the regression lines of the amygdalectomized animals and the control group. Regression of weight on time from the date of initiation of *ad lib.* feedings reveals the rate of weight gain of the amygdalectomized animals to be significantly greater than that of the controls, the differences between the slopes being significant at a probability of less than 1 per cent. The trend of the experimental group can best be described by the linear regression $Y = 116{\cdot}84 + 1{\cdot}39\ X$. This slope is significantly different from zero at a probability of less than 0·1 per cent. The trend of the control group can best be described by the linear regression $Y = 105{\cdot}77 + 0{\cdot}469\ X$, this slope also being significantly different from zero at a probability of less than 0·1 per cent.

In order actually to determine whether or not there really was an increase in food intake, the daily food rations were weighed over two three-day periods. Table 1 shows that the amygdalectomized animals consumed a mean of 154·38 gm. of food daily (dry weight), whereas the control group consumed 125·87 gm. daily (dry weight), the differences in food intake by group comparison being significant at the 0·1 per cent level of probability. Table 2 shows the changes in weight of the amygdalectomized and control animals over the entire period of observation with probability-levels between the different periods.

This study reveals that a significant gain in weight and increase in intake of food result from bilateral amygdalectomy in the cat. Several previous studies have rather casually referred to alterations in eating behaviour after medial temporal operations, notably those of Kluver and Bucy[4] and Pribram and Bagshaw[5] in the monkey, and Fuller, Rosvold and Pribram[6] in dogs. The only quantitative study is that of Anand and Brobeck[7] in rats and cats. After stereotaxic destruction of the amygdaloid nuclei they did not obtain any alteration in food intake in those animals in which the lesions were restricted to the amygdala. It may be pointed out that not only was the method different from our own, but also that all the animals in this group were killed at an early date, within six to eight weeks of the surgical procedure.

Although all our experimental animals have shown a significant gain in weight as compared with the control group, this gain in body-weight has in no

Table 1. Food Intake of Amygdalectomized and Control Cats over Two Three-day Periods

Group	*n*	Mean weight (gm.) of horse-meat eaten/day over two 3-day test periods (dry wt.)
Amygdalectomies	9	154·38 ± 6·57
Controls	7	125·87 ± 3·93

±S.E. Difference between amygdalectomies and controls: $P < 0{\cdot}001$.

Table 2. Weight Changes of Amygdalectomized and Control Cats over the Entire Period of Observation with Probability Levels between the Different Periods

Group	*n*	I Mean initial weight (oz.)	II Mean weights at time of *ad lib.* feedings (oz.)	III Mean weights 225 days *ad lib.* feeding (oz.)	Mean % gain I–III
Amygdalectomies	9	100·60 ± 4·66	117·60 ± 4·03	138·40 ± 4·28	38·90 ± 4·95
Controls	7	104·60 ± 3·89	106·20 ± 3·95	112·90 ± 3·82	8·08 ± 1·10

±S.E.

Probability

Amygdalectomies *vs.* Controls (direct comparison)	I: $P > 0{\cdot}40$	II: $P > 0{\cdot}05$	III: $P < 0{\cdot}001$
Amygdalectomies *vs.* Controls (differences in weight)	I *vs.* II: $P < 0{\cdot}001$	II *vs.* III: $P < 0{\cdot}001$	

case been as marked as that reported by other observers following lesions in the ventro-medial hypothalamic nuclei[8,9]. In our animals the mean percentage gain over the entire period of observation was, as seen from Table 2, 38·90 per cent for the experimental animals and 8·08 per cent for the controls, whereas doubling of the body-weight over similar periods has by no means been uncommon with hypothalamic lesions. From this, it can be said that the amygdaloid complex may constitute one means of control of feeding activity in the cat. In this respect it is significant to recall the existence of strong anatomical connexions between the amygdala and the ventro-medial hypothalamic nucleus.

Due to the fact that our studies are still in progress, anatomical control cannot be given and the extent of the lesions is not yet known. However, it is difficult to postulate what other structures in this general region could account for the observed hyperphagia. Extension of the lesion medially would invade the lateral hypothalamus, lesions of which have been shown to produce aphagia[10], opposite to what we have obtained.

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STRUCTURE OF THE LIQUID-CRYSTAL PHASES OF THE SOAP – WATER SYSTEM: MIDDLE SOAP AND NEAT SOAP

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THIS communication describes an X-ray diffraction study of the middle soap and neat soap phases of the soap – water system.

The phase diagram shown in Fig. 1 is that of the system potassium palmitate – water[1], but is characteristic of soap – water systems in general. Below the curve T_c, in Fig. 1, is the region of gel and coagel in which the system is not always in equilibrium. Above the curve T_i there is isotropic solution. In the region between these two curves the system shows properties characteristic of liquid crystalline structures (high viscosity, optical anisotropy, etc.). The middle soap and neat soap, with which we are here concerned, form two distinct phases in this region.

X-ray diagrams were obtained with a Guinier-type focusing camera and a bent-quartz monochromator. The camera was evacuated, and the specimen could be maintained at temperatures from 20° to 150° C. A Philips diffractometer, to which a bent-quartz monochromator was fitted, was also used.

Measurements on the sodium and potassium salts of a number of saturated fatty acids in the range C_{12}–C_{18} all gave similar results. We describe here the results of a systematic study of the structure of potassium palmitate (KC_{16}) as a function of concentration (10–90 per cent soap) and temperature (20°–100° C.).

Variation of X-ray diagrams with concentration. The X-ray diagrams show a considerable variation with concentration. For example, at 100° C. (see Fig. 1) the following results are obtained.

In the micellar region (concentration 10–30 per cent) the diagrams show only diffuse bands. At all higher concentrations—that is, in the anisotropic zone—lines as fine as those given by crystalline materials are observed. At about 30–33 per cent concentration, in the zone between the micellar and the middle soap phases, the diagrams contain both the diffuse bands of the micellar and the sharp lines of the middle soap structures.

At about 33–53 per cent concentration, in the middle soap region, there is a series of sharp lines corresponding to Bragg spacings in the ratio $1 : 1/\sqrt{3} : 1/\sqrt{4} : 1/\sqrt{7}$. The only other feature of the diagrams, in this concentration range, is a weak and diffuse band at about 4·5 A.

At about 64–87 per cent concentration, in the neat soap region, the X-ray diagrams contain from two to five lines giving Bragg spacings in the ratio $1 : 1/2 : 1/3 : 1/4 : 1/5$. Again, the only other feature is the weak, diffuse band at about 4·5 A.

In the intermediate zone, at concentrations of about 53–64 per cent, the X-ray diagrams are complex, and are not simply a superposition of the middle soap and neat soap diagrams.

Variation of X-ray diagrams with temperature. Change of temperature at constant concentration

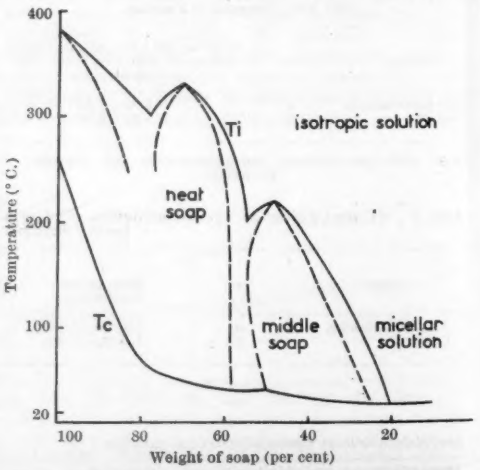

Fig. 1. Phase diagram of the potassium palmitate – water system

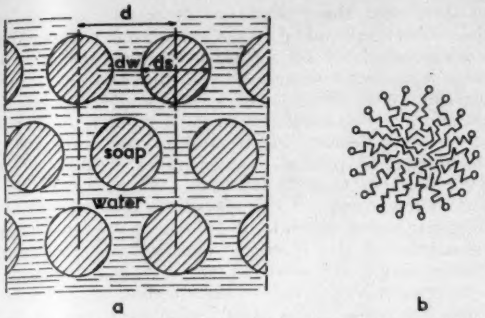

Fig. 2. (*a*) Schematic structure of middle soap; (*b*) cross-section of a cylinder

produces no change in the general character of the X-ray diagram, provided that no phase boundary is crossed; that is, within these limits, the ratio of the Bragg spacings characteristic of the phase concerned is preserved. However, the spacings themselves decrease as the temperature is increased: the linear thermal coefficient is -1×10^{-3} to -2×10^{-3} per deg. C. This effect is characteristic of a structure which is partially 'liquid', and is observed in certain partially extended polymers. (Note that, under the same conditions, the thermal expansion of the large parameter of crystalline soap is $+5 \times 10^{-5}$ per deg. C.)

It has been shown[2] that the coefficient of thermal expansion of a random coil, partially extended by the application of equal and opposite forces at its extremities, is given by:

$$\alpha = \frac{dr}{rdT} = -\frac{1}{T}$$

where r is the distance between the two ends of the chain. For $T = 373°$ K. this gives $\alpha \doteq -2{\cdot}68 \times 10^{-3}$. Assuming that the thermal expansion of water is negligible, it is possible to calculate the diameter of the cylinder (in the middle soap) and the thickness of the double soap layer (in the neat soap) (see below) at different temperatures, and to compute the thermal expansion coefficient of the soap alone: the average value obtained is $\alpha \simeq -3 \times 10^{-3}$. The agreement between the theoretical and the experimental value of α is excellent.

These results suggest that, in both middle soap and neat soap, the hydrocarbon chains are disordered but have some degree of preferential orientation in the direction perpendicular to the soap – water interface. Further evidence that the chains are more nearly 'liquid' than 'crystalline' is provided by the fact that the diffuse band at 4·5 A. is identical with that given by liquid hexadecane.

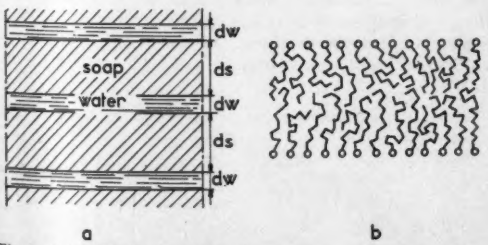

Fig. 3. (*a*) Schematic structure of neat soap; (*b*) section of a soap double layer

Middle soap: The X-ray diagrams indicate the presence of a structure consisting of long, identical, parallel rods in regular hexagonal array. The polar groups of the soap molecules must, presumably, lie at the surface of these rods, and the hydrocarbon chains in the interior. From the distance between the axes of the rods (given by the X-ray diagrams), the concentration of the soap and the density of the soap (taken to be 0·9 gm./cm.^{3}), the diameter of the rods (assuming that the rods are circular cylinders) and the thickness of the layer of water between them can be calculated. The results are shown in Table 1 (see Fig. 2*a*).

Table 1

Soap concentration (per cent)	d (in A.)	ds	dw
31·4	62·0	37·8	24·2
35·4	59·0	38·1	20·9
40·4	55·8	38·4	17·4
44·3	53·5	38·5	15·0
46·1	52·8	38·7	14·1
48·2	51·0	38·2	12·8
51·4	49·8	38·4	11·4

It is clear that the diameter of the rods is independent of the concentration of soap in the middle soap phase. The 'liquid' hydrocarbon chains fill the interior of the rods uniformly (see Fig. 2*b*).

Neat soap: The X-ray diagrams indicate a structure consisting of parallel, equidistant sheets. These sheets are, presumably, formed of a double layer of soap molecules, and separated from one another by a layer of water. From the inter-sheet spacing and the density and concentration of the soap, the thickness of the sheets and of the layer of water between them can be calculated. The results are given in Table 2 (see Fig. 3*a*).

Table 2

Soap concentration (per cent)	d (in A.)	ds	dw
67·7	37·4	26·2	11·2
70·0	36·4	26·3	10·1
73·3	35·8	27·0	8·8
76·4	35·8	28·0	7·8
80·0	35·9	29·3	6·6
81·9	36·3	30·3	6·0
84·9	36·4	31·4	5·0
87·9	37·1	33·0	4·1
Crystal 100	40·1	40·1	0

As the soap concentration increases, the thickness of the sheets increases and that of the water layer between them decreases. The increasing thickness of the double layer of soap molecules must be attributed to a stiffening of the hydrocarbon chains as the structure approaches that of an anhydrous soap crystal (see Fig. 3*b*).

The two structures described above are types of liquid crystals. In the Friedel classification, the neat soap is smectic. The middle soap structure resembles Friedel nematic 'stase', but has an additional degree of order, the structural elements being not only parallel but also equidistant. This may be compared with the structure of concentrated solutions of tobacco mosaic virus, described by Bernal and Fankuchen[3].

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Radio Observations of the Comet Arend-Roland

The observation of radio emission from the Comet Arend-Roland has been reported[1] at 600 Mc./s. and[2] at 27·6 Mc./s. The reported flux densities are of the order of 5×10^{-23} (private communication) and 5×10^{-22} W.m.$^{-2}$ (c./s.)$^{-1}$ respectively, or about 2 per cent and 3,000 per cent of the flux density of the quiet Sun. Observations[3] at 400 Mc./s. failed to detect any emission, though the sensitivity was high enough to detect a flux density less than 10^{-24} W.m.$^{-2}$ (c./s.)$^{-1}$.

Observations were made at Cambridge during periods between March 12 and May 13 in an attempt to detect radio emission from the comet at frequencies of 38 and 81·5 Mc./s., and by observing radio stars through its tail to derive information on the electron density, in the manner used by Hewish[4] in investigating the outermost layers of the solar corona.

Five different instruments were used. Two were interferometers of large resolving power used to detect any scattering of the radiation from radio stars situated behind the comet's tail. These instruments also enabled a very low limit to be placed on the radio emission from the head. The possibility of radio emission from the extended tail was investigated with interferometers of smaller resolving power, but these were of lower sensitivity, so the derived upper limit of intensity is greater.

In no case was any detectable effect observed; the upper limits of the flux density are given for the different periods in Table 1. A number of records were spoiled by intense emission from the Sun, and some at 38 Mc./s. by man-made interference; the best observations at this frequency were therefore obtained at night near lower culmination when the comet had moved sufficiently far north.

Solar emission also prevented the observation of three comparatively intense radio stars through the comet's tail. The observation of weaker stars was possible on a number of occasions between April 13 and May 13, but none of these was sufficiently well defined on the records to allow an individual measure of the scattering produced. It was, however, possible to show that there would be detectable changes in the record amplitude if all the weaker unresolved radio stars situated behind the tail were obscured or were subject to scattering greater than the resolution of the interferometer. No such effect was found, and it may therefore be concluded that the irregular variations of electron density in the tail of the comet were insufficient to produce scattering as great as ½° at 81·5 Mc./s. or 1° at 38 Mc./s.

Table 1

Frequency (Mc./s.)	Interferometer spacing (wavelengths)	Maximum diameter observable (degrees)	Dates	Upper limit to flux density of comet ($\times 10^{-24}$ W.m.$^{-2}$ (c./s.)$^{-1}$)
81·5	120	1/4	April 13–24	3
			April 25–May 8	0·5
	10	3	April 13–May 8	5
	5	6	March 12–20	60
38	60	1/2	April 11–23 (4 days)	3
			(3 days)	15
			April 26–May 4	0·5
			May 5–13	0·25
	10	3	March 31–April 24 (10 days)	40

The magnitude of the scattering produced by an irregular region depends on ΔN, the root-mean-square departure of the electron density from the mean value, and l, the scale of the irregular structure[4]. The present observations indicate that $\Delta N/\sqrt{l}$ is less than 100, when ΔN is measured in electrons per cm.^{3} and l in kilometres.

Optical photographs of the tail of the Comet Arend-Roland show structure as fine as 10,000 km., leading to an upper limit of 10^4 for ΔN; it is probable that finer structure exists, and the limit of ΔN would then be smaller.

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Rotational Analysis of the Tantalum Oxide Bands

Bands of the tantalum oxide molecule have been photographed in the ultra-violet and the visible regions on a 21-ft. concave grating in the Department of Physics, University of Stockholm, in the first order, giving a reciprocal dispersion of about 1·2 A./mm. The previous analyses[1] are found to be incorrect. The revised analysis shows that the bands in these regions can be divided into two systems A and C. Bands of system C consist of two sub-systems with their (0,0) bands at $\nu\nu$24064 and 23348. Rotational structure of the (2,0), (3,1), (1,0), (2,1), (0,0) and (0,1) bands of system A, (1,0) and (0,0) bands of the sub-system ν24064 and (1,0), (0,0) and (0,1) bands of the other sub-system of C has been analysed. Bands of system A show only two branches each and are ascribed to the transition $c^2\Delta_{3/2}$–$a^2\Delta_{3/2}$. Strong Q branches are very prominent in all the bands of system C. Large Λ-type doubling is observed in the upper state levels and is found to vary linearly with J in the sub-system ν23348. The bands are ascribed to the transition $b^2\Pi$–$a^2\Delta$. All three states involved belong to Hund's coupling case (a). The vibrational and rotational constants obtained are given in Table 1.

Table 1. Constants of Tantalum Oxide

State	ω_e (cm.$^{-1}$)	$x_e\omega_e$ (cm.$^{-1}$)	B_e (cm.$^{-1}$)	α_e (cm.$^{-1}$)	r_e (A.)
$c^2\Delta$	903·01	4·15	0·3775	0·0019	1·743
$b^2\Pi$	898·5	4·1	0·3772	0·0019	1·744
$a^2\Delta$	896·0	5	0·402	0·0020	1·687
	1,031·7				

The coupling constant A for the $b^3\Pi$ state is of the order of 1,000 cm.$^{-1}$, while that of $a^3\Delta$ is either about 300 or 1,700 cm.$^{-1}$ according as the state is regular or inverted. It could not be ascertained whether the two states are regular or inverted; however, either both states are regular or both inverted.

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The Compound Polarizer

THE compound polarizer is a device for producing beams of polarized light of variable colours in the field of a microscope ocular. The polarizer proper consists of a disk of 'Polaroid', a disk of polythene and a disk of 'Rayophane', in that order from the light source; each of these disks can be rotated around a common axis. The analyser consists of a disk of 'Polaroid' within the microscope as near the objective as possible; it is fixed with respect to rotation but can slide upwards and downwards as objectives are changed by rotation of the microscope nosepiece. The beam of light passing through to the specimen examined must be convergent, a condition fulfilled by the ordinary substage condenser with no lens removed. The polarizer and analyser are in the fully uncrossed position relative to each other. The assemblage works as follows.

Plane polarized light coming from the polarizer is rotated by the polythene disk, and whatever elliptical polarization the light undergoes in traversing this disk is increased as the light traverses the 'Rayophane' disk. Accordingly, a beam of white light from the source is seen as coloured light through the microscope. The colour will vary according to the rotation of both the 'Rayophane' and polythene disks about the common axis. The standard setting is that which produces a well-marked lilac colour, the colour of the flower of *Syringa vulgaris*. A graded series of other colours is produced by rotation of the polythene disk clockwise or anti-clockwise. Rotated in one direction we get the series red, orange, yellow, white; rotated in the other direction we get the series deep blue, light blue, greenish-blue, white. In either case the colour is more and more diluted with white light as we move towards the white end-point, but the red, orange and blue colours are quite intense. The lilac 'background' colour corresponds to the darkening of the field obtained in the crossed-nicols position with plane polarized light, as can be shown by spectroscopic examination. When a colour filter is enclosed in the light source, a corresponding darkening is obtained by rotating the polythene disk in such a direction and to such an amount as would give a background colour complementary to the coloured light used. These analogues to the crossed-nicols position give the best results in the examination of anisotropic material. Isotropic material takes the background colour. In all cases it is advisable to use the ground-glass diffusion screen below the condenser, the common 'Daylight' filter being the most suitable.

This device enables the worker to carry out 'optical sectioning' of anisotropic material in the specimen because of the remarkable separation of the focal planes of differently coloured elements orientated at different angles. The function of the polythene disk is twofold: it produces the graded spectral series of colours (green excepted) already mentioned, and it 'gears down' the rapidity of transition from one colour to the next. 'Styrafoil', referred to by Gaythorpe[1] in an earlier communication, has much the same effect, but the colour change is much more rapid and the resolution of the image does not seem to be so good as with polythene. The polythene used is that employed for the manufacture of cosmic-ray balloons. 'Rayophane' is that manufactured by the British Rayophane Company, Ltd., and supplied to John Player and Sons, Ltd. It has an average thickness of 23μ, and for the best results sections examined by this method should have a minimum thickness approaching this. Sections of 50μ thickness are useful for many purposes where the general disposition of anisotropic elements rather than fine detail is required. Apart from its obvious use with skeletal and epithelial tissues, the method seems to have a special field of application in the examination of the nervous system. Frozen sections of the central nervous system, mounted in glycerol or glycerol jelly, can be made to show the precise disposition and course of myelinated fibres to, through and from the grey matter, by rotating the stage. Full details of theory and practice will be submitted for publication later to the *Irish Journal of Medical Science*.

I thank Messrs. British Rayophane, Ltd., for supplying very full details of the nature and manufacture of 'Rayophane'. It should be mentioned that the material inadvertently called 'Cellophane' in the earlier communication from Fahy and MacConaill[2] was in fact 'Rayophane', kindly given by Messrs. Players (Dublin) to me.

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May 29.

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Excess Zinc in Zinc Oxide

A METHOD for determining excess zinc in zinc oxide has been devised[1]. It is based on measurement of the hydrogen produced by the excess metal when the sample is dissolved in hydrochloric acid. It will detect 0·05 μgm. of excess zinc. This communication summarizes the results obtained by the method with oxide in various states.

Dark orange and pale green single crystals, obtained through the courtesy of the National Smelting Co., Avonmouth, and believed to be of high purity, but non-stoichiometric, contained respectively 25·3 and 6·3 p.p.m. excess zinc/zinc oxide by weight (1 p.p.m. excess zinc/zinc oxide by weight $= 1{\cdot}25 \times 10^{-6}$ fractional excess of cations). Heating the crystals at 1,300° C. in air (30 min. followed by cooling to room

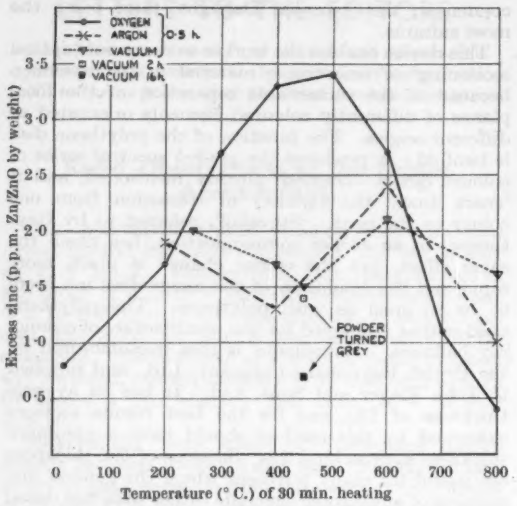

Fig. 1

temperature in less than 1 min.) reduced the excess zinc to 2·3 and 3·1 p.p.m. respectively. (The values quoted throughout this communication are usually the mean of at least two measurements.)

Pressings of zinc oxide powder (analytical reagent grade or better) which were sintered in air or oxygen at 1,000–1,200° C. contained excess zinc in the range 1·7–5·6 p.p.m. On the other hand, sintering in argon (containing not more than 10^{-2} mm. mercury pressure of oxygen) at 1,300° C. gave 13·0–18·0 p.p.m., while a loose powder also heated in argon at 1,300° C. gave 16·8 p.p.m.

The above results showed the expected change of non-stoichiometry with the oxygen content of the surrounding atmosphere. But at lower temperatures the opposite behaviour was observed.

Fig. 1 shows the effect on the excess zinc content of heating a powder (as made by the indirect process and stored in air; analytical reagent grade or better, 0·1–1 micron diameter particles) for 30 min. at temperatures up to 800° C. in oxygen, in argon or *in vacuo* (about 10^{-4} mm. mercury pressure outside the powder), with cooling to room temperature in gas or *in vacuo* as appropriate in 5 min. The well-defined maximum in oxygen, the minima *in vacuo* and in argon, all at 400–500° C., will be noted. They may perhaps be connected with the appreciable adsorption of oxygen[2] and the dissociation of the oxide *in vacuo* after previous exposure to oxygen[3], both reported in this temperature-range. (The identity of temperature of the present and previously reported phenomena probably constitutes the strongest evidence for non-stoichiometry rather than free zinc in the heated powders.)

Heating *in vacuo* at 450° C. for longer periods reduced the excess zinc content (Fig. 1) and the powder turned grey[3,4]. Similar behaviour of a second powder was observed. Thus grey oxide is not rich in excess zinc, either in the lattice or as free metal. Only zincite could be detected on examination of the grey powder by electron diffraction. A reduction of non-stoichiometry at the onset of dissociation may be implied. This phenomenon was reported[3] for cadmium oxide at higher temperatures.

A reduction of excess zinc with time *in vacuo* at 450° C. was also observed with crushed sintered material (about 50-μ single-crystal particles) initially containing 17·8 p.p.m. excess zinc. The values after 0·5, 2·0 and 16 hr. were respectively 10·3, 7·7 and 0·5 p.p.m. (If diffusion of excess zinc out of the particles were controlling the rate, the diffusion coefficient for excess zinc at 450° C. would have been of the order 10^{-10} cm.^{2} sec.$^{-1}$.)

The powder giving the results in Fig. 1 initially contained 0·8 p.p.m. excess zinc. However, analysis of eight other powders made by the indirect process showed that the initial excess zinc content was not always so small, contents up to 5·9 p.p.m. being found. There appeared to be a correlation between the excess zinc and sintering behaviour. The sintering of powder containing more than about 2·5 p.p.m. was enhanced[5] by oxygen, while that of powder containing less excess zinc was retarded by oxygen. This result also favours non-stoichiometry rather than free zinc.

The highest content of excess zinc observed, 42·9 p.p.m., was found with bright yellow powder (particles of 1 micron diameter or less) produced by scraping sintered material (3·3 p.p.m.) with a non-metallic knife.

Ehret and Greenstone[6] and von Wartenburg[7] found excess zinc in zinc oxide within the range 0·02–1 per cent, but the method of preparation of the specimens in each case gives grounds for believing that these relatively high figures may not entirely represent non-stoichiometry.

Mr. D. Clark is thanked for the electron diffraction work and Messrs. C. Wheeler and G. Christie for other experimental help.

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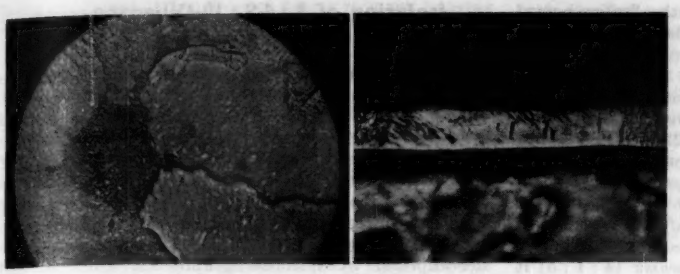
Grain-Growth in Metals by Cyclic Stress

It is well known that the crystal grains constituting a metal are fragmented into crystallites by the application of a cyclic stress greater than the endurance limit. Little is known, however, as to the grain-growth in a plating metal caused by cyclic stress.

When a specimen of steel which is plated with copper is submitted to reversals of cyclic stress, the micro-grains in the plating metal grow to a considerable size when the magnitude of the cyclic stress passes a certain limit. This limiting value of the cyclic stress is very near the endurance limit of annealed copper.

An examination by microscope of the surface and cross-section of a specimen after loading, electro-polishing and etching, reveals the growth of grains



Figs. 1 and 2. Grown grain and original micro-grains, after direct stress of ± 20 kgm./mm.^{2} for 5 × 10^6 cycles. × 1,000

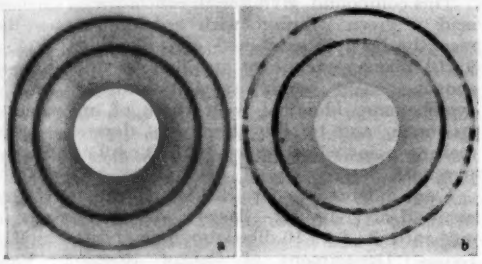


Fig. 3. X-ray pattern: (*a*) before loading; (*b*) after direct stress of ± 22 kgm./mm.^{2} for 11 × 10^6 cycles

in the plating metal. Figs. 1 and 2 are micrographs of the plating metal showing grains which have grown and the neighbouring original micro-grains. Comparison of the X-ray patterns, before and after loading, also suggests the growth of grain due to cyclic stress. The X-ray patterns before and after loading are shown in Fig. 3. The stress indicated underneath each figure is not the true value in the plating metal but is a nominal one based on the elastic moduli of the steel base.

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Separation of Talosamine from other 2-Amino Hexoses

In a sample of N-acetylgalactosamine prepared by the N-acetylation of galactosamine isolated from sheep tracheal cartilage, a substance has been detected which gives the reactions of an N-acetyl-2-amino hexose but which is not N-acetylgalactosamine or N-acetylglucosamine.

The preparation of N-acetylgalactosamine was examined by paper chromatography in several solvent systems. When sprayed with the hexosamine reagents to reveal N-acetyl-2-amino aldoses[1], two reddish-purple spots appeared; one of these occupied a position identical with that of N-acetylgalactosamine, whereas the other differed in position from both N-acetylgalactosamine and N-acetylglucosamine. When chromatograms were sprayed with anisidine hydrochloride, the light-brown colour produced in the position of the new spot indicated that it was probably due to an N-acetylhexosamine, since only N-acetylhexosamines have been observed to give this colour under these conditions (Davies, D. A. L., and Crumpton, M. J., unpublished work). The *R*(glucose) values on Whatman No. 1 paper for the new sugar, N-acetylglucosamine and N-acetylgalactosamine in butanol/pyridine/water (3 : 2 : 1·5), were 1·46, 1·28 and 1·20 respectively. The component responsible for the faster-running spot was separated from N-acetylgalactosamine on washed Whatman No. 31 thick paper by the usual method of band chromatography with marginal vertical strips to indicate its position. From a 25 mgm. sample of the N-acetylgalactosamine preparation applied to the paper, approximately 2·5 mgm. of the new component was separated. No N-acetylgalactosamine could be detected in the separated material by paper chromatography.

The absorption spectrum of the chromophore formed by the sugar after treatment (4 min., 100° C.) with 0·05 *N* sodium carbonate and addition of the *p*-dimethylaminobenzaldehyde reagent was identical with those given by N-acetylgalactosamine and N-acetylglucosamine[2]. The optimum heating period for maximum colour production under the conditions employed was 4 min., and the sugar resembled N-acetylgalactosamine in that it gave only about one-fifth of the colour given by an equal weight of N-acetylglucosamine[2].

The separated sugar was deacetylated by hydrolysis with 0·5 *N* hydrochloric acid for 6 hr. at 100° C. The hydrolysate was analysed on columns of 'Zeo-Karb 225' resin by a modification of the method of Gardell[3]. Columns were developed with 0·33 *N* hydrochloric acid which separated not more than 2 per cent of galactosamine from a slower running component (Fig. 1). When glucosamine and galactosamine were added to the hydrolysate, three components could be separated completely from one another, emerging in the order, glucosamine, galactosamine and the new amino-sugar. The absorption

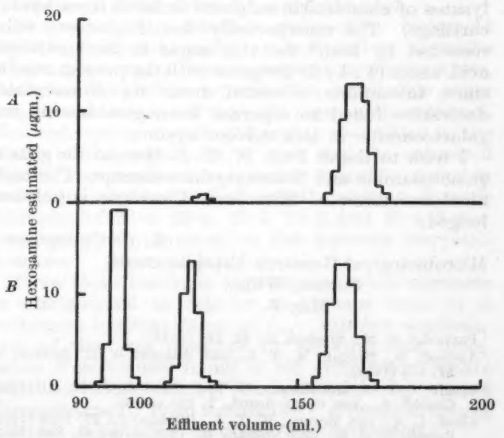

Fig. 1. Separation of amino-sugars on a column of 'Zeo-Karb 225' resin. *A*, a new amino-sugar (talosamine); *B*, the same sugar with added glucosamine and galactosamine

spectrum of the latter on reacting with alkaline acetyl acetone and the *p*-dimethylaminobenzaldehyde reagent[4] was identical with those given by glucosamine and galactosamine.

Although the amino-sugar when deacetylated could be distinguished from glucosamine and galactosamine using columns of 'Zeo-Karb 225', this was not possible on paper chromatograms developed in butanol/pyridine/water or *s*-collidine, where it occupied a position identical with that of glucosamine. When phenol/ammonia was employed as solvent, the sugar could not be distinguished from galactosamine, and in butanol/acetic acid/water (4 : 1 : 5) it did not separate from the glucosamine–galactosamine position.

Examination by paper chromatography of the products of its oxidative deamination with ninhydrin[5] revealed the presence of a pentose which was neither arabinose nor ribose but which occupied a position close to that of lyxose or xylose. Since lyxose and xylose are not widely separated in the solvent systems employed, that area of the chromatogram corresponding to the lyxose–xylose region was eluted and the eluate examined by paper electrophoresis using a 0·05 *M* borate buffer (*p*H 9·6). Under these conditions, lyxose and xylose separated completely and the pentose formed by the amino-sugar occupied a position identical with that of lyxose. It is therefore concluded that the sugar is the epimer of galactosamine, namely, 2-amino-2-deoxy talose, and that the preparation of N-acetylgalactosamine used contained some N-acetyltalosamine. Since talosamine has not been detected in certain other samples of galactosamine isolated from sheep tracheal cartilage and which had not been N-acetylated, it cannot be assumed that the sugar occurs naturally.

The behaviour of talosamine on paper chromatograms using a variety of solvent systems indicates that a spot in the position of glucosamine or galactosamine is insufficient evidence for the identification of these sugars. A satisfactory method of analysis is the use of columns of 'Zeo-Karb 225' resin with 0·33 *N* hydrochloric acid as eluant, combined with a chromatographic examination of the N-acetylated amino-sugars on paper.

Since this work was completed, Muir[6] has described the presence of talosamine in acid hydrolysates of chondroitin sulphate isolated from hyaline cartilage. The unexpectedly low *R*(glucose) value recorded by Muir[6] for this sugar in butanol/acetic acid/water (4 : 1 : 5) disagrees with the present results, since talosamine obtained from its N-acetylated derivative failed to separate from glucosamine and galactosamine in this solvent system.

I wish to thank Prof. W. T. J. Morgan for gifts of galactosamine and N-acetylgalactosamine. The technical assistance of Miss Joan Pleasants is acknowledged.

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Isolation of 3 : 4-9 : 10-Dibenzopyrene from Coal-Tar

By fractionation of coal-tar on alumina, Berenblum and Schoental[1] demonstrated that the fraction preceding and that following the one containing 3 : 4-benzpyrene were carcinogenic to rodents though free from spectrographically detectable amounts of 3 : 4-benzpyrene. Fractional crystallization of picrates from the fraction following the one containing 3 : 4-benzpyrene gave, among others, reddish-brown needles melting at 160–189° C. These picrates were decomposed by chromatography on alumina, and after repeated crystallizations from various solvents yielded yellow glistening scales, melting with some softening at 280° C.

This compound, giving with concentrated sulphuric acid a green solution with red fluorescence, has recently been re-examined and identified as 3 : 4-9 : 10-dibenzopyrene by its fluorescence spectrum showing main bands at 432 and 460 mμ in cyclohexane, identical with those of an authentic specimen, and by the absence of depression of its melting point when mixed with 3 : 4-9 : 10-dibenzopyrene[2,3].

I am indebted to Dr. E. Clar, Chemistry Department, University of Glasgow, for a specimen of authentic 3 : 4-9 : 10-dibenzopyrene and to Mr. M. J. Lyons, Department of Cancer Research, Royal Beatson Memorial Hospital, Glasgow, for the fluorescence spectra.

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Conversion of Glycogen to Sorbitol and Glycerol in the Diapause Egg of the *Bombyx* Silkworm

In the course of biochemical studies[1] on the embryonic diapause of the *Bombyx* silkworm, it has been shown that the glycogen content of the egg decreases markedly at the onset of diapause and reaches the lowest level at about thirty days after oviposition. When diapause is broken by cold treatment, glycogen increases progressively even at low temperature and regains the initial level almost completely. Pursuing the fate of glycogen during the diapause period, I have found that it is not consumed as an energy source, but it is converted to other substances including the following: sugars and their polymers, fat, lactic acid, gluconic acid and other organic acids such as Krebs cycle members, phosphoric esters and amino-acids.

It has been found that the main bulk of glycogen is converted into two kinds of polyhydric alcohols, namely, sorbitol and glycerol. Fig. 1 shows the chromatogram of the polyhydric alcohols extracted from the diapause eggs and Table 1 gives the R_F values of these alcohols in various solvents. It is apparent from the chromatogram reproduced as Fig. 1 that the marked decline of glycogen at the onset of dia-

Table 1. R_F VALUES OF TWO SPOTS OF SAMPLE FROM THE DIAPAUSE EGGS, AND THOSE OF VARIOUS POLYHYDRIC ALCOHOLS AND ASCORBIC ACID

	Solvent *A*	Solvent *B*	Solvent *C*	Solvent *D*	Solvent *E*
Sample from diapause egg	0·54 0·30–0·31	0·51 0·26	0·60 0·35	0·26 0·06	0·11 Origin
Glycerol	0·54	0·51	0·60	0·25	0·11
d-Sorbitol	0·31	0·26	0·35	0·06	Origin
d-Mannitol	0·33	—	—	—	—
Inositol	0·18	—	—	—	—
Ascorbic acid	0·44	—	—	—	—

Two spots of sample from the diapause eggs are strongly positive for ammoniacal silver nitrate alone and completely negative for both aniline hydrogenphthalate and orcinol reagents. This fact indicates clearly that the substances in question are not sugars, but are polyhydric alcohols. Solvent *A*: butanol/acetic acid/water (4 : 1 : 2); *B*: butanol/ethanol/water (4 : 1 : 2); *C*: butanol/pyridine/water (3 : 2 : 1·5); *D*: ethyl acetate/acetic acid/water (3 : 1 : 3); *E*: chloroform/ethanol (8 : 2)

pause is coupled with the formation of sorbitol and glycerol, only traces of which are found before and after diapause. Quantitative analysis has been carried out, based upon the oxidation with periodate of the alcohols eluted from the filter paper and subsequent colour reaction with chromotropic acid[2]. The results indicated that the highest contents of sorbitol and glycerol found during the diapause period amounted to 23 mgm. and 11 mgm. respectively per gram of fresh eggs, thus accounting quantitatively for the decrease of glycogen. In other words, glycogen is converted completely into these two alcohols during the diapause period. So far as I am aware, the presence of sorbitol in animal tissues has not been reported hitherto or the accumulation of glycerol to such an extent, except in some microorganisms under special conditions.

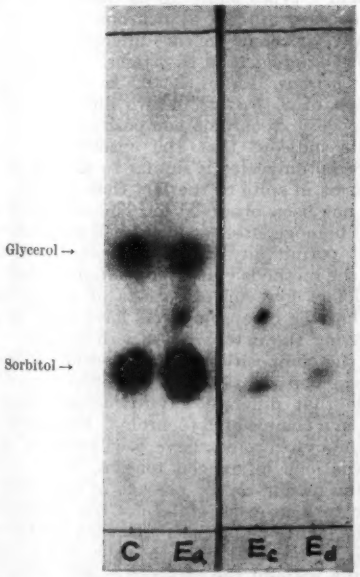

Fig. 1. Chromatogram of polyhydric alcohols found in the *Bombyx* silkworm egg. Detection of spot: ammoniacal silver nitrate. Solvent: butanol/acetic acid/water (4 : 1 : 2). *C*: sorbitol and glycerol as control; E_a: sample from eggs during diapause period (minimal glycogen stage); E_c: sample from the eggs just before onset of diapause (12 hr. after oviposition, maximal glycogen stage); E_d: sample from the eggs after termination of diapause (glycogen maximum again)

A detailed account of this work and related experiments will be reported elsewhere.

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C_{12}-Hydroxylation of Digitoxin

USING paper chromatographic methods it has been shown that, following digitoxin administration to rats, the urine contains small amounts of unchanged digitoxin together with larger quantities of two cardioactive metabolites previously designated metabolites *C* and *G*[1,2]. Human urine collected for 12 hr. from normal adults after an oral dose of 1 mgm. of digitoxin has now been found to contain some unchanged digitoxin as well as apparently larger quantities of two metabolites. The two metabolites when eluted from paper and rechromatographed using two systems of paper chromatography could not be separated from metabolites *C* and *G*.

Furthermore, metabolite *G* could not be separated from the glycoside digoxin (12-hydroxydigitoxin) by paper chromatography on formamide paper using three different developing solvents (benzene, chloroform, butanol[1]; tetrahydrofurane, chloroform[3]; and methyl *iso*butyl ketone, *iso*propyl ether[4]) or by the reversed phase systems I and II of Tschesche, Grimmer and Seehofer[5].

After elution from paper, metabolite *G* was refluxed with 0·5 per cent hydrochloric acid, extracted with chloroform, and yielded a substance which was indistinguishable from digoxigenin when compared on two systems of paper chromatography. Furthermore, this hydrolytic product when dissolved in concentrated sulphuric acid gave an ultra-violet absorption spectra with peaks at 390 and 470 mμ, similar to digoxigenin under the same conditions. This spectrum was distinctly different from that of 11-hydroxy digitoxigenin (sarmentogenin) and of epi-sarmentogenin taken in sulphuric acid.

Biosynthetically labelled radioactive carbon-14 digitoxin[6] diluted with non-radioactive digitoxin (2 μgm./gm.) was injected intraperitoneally into rats, the urine metabolites separated on formamide paper strips[1], and then eluted from the paper with methanol. Non-radioactive digoxin (10 mgm.) was added to the eluate of the metabolite *G* area and the recovered digoxin recrystallized to constant specific activity in order to confirm radiochemical purity. Specific activities of 22·6, 20·8, 22·0, 21·0 and 20·4 d.p.m. per mgm. were obtained on five separate recrystallizations.

From these results it appears that when digitoxin is administered to rats or to humans some of it undergoes hydroxylation at C_{12}. Further confirmation of this was obtained by showing that metabolite *B* previously found in rat urine after digoxin administration[7] cannot be separated by paper chromatography from metabolite *C* present in human and rat urine after digitoxin administration.

It is hoped to publish this work in detail elsewhere. One of us (S. E. W.) wishes to thank the Pharmacology

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Cytochrome Composition of Some Strains of *Streptomyces*

Smith[1] has discussed the bacterial cytochromes in relation to each other and in comparison with those from yeast and mammalian sources. Her review serves to emphasize the variations existing among the bacteria, and the fact that generalizations concerning the functions of the various cytochromes are difficult to make. Since information concerning even the existence of cytochromes in Streptomycetes is meagre[2], it was felt that a spectrophotometric survey of the general cytochrome composition of various strains would provide a useful basis for more complete investigations of a physiological nature and contribute to the microbial cytochrome picture in general. Furthermore, the activity of Streptomycetes as prolific producers of antibiotics and as producers of vitamins makes a better understanding of their physiology of considerable interest. In this regard, various investigations have shown that iron is required in media used for antibiotic production by Streptomycetes[3], and a recent investigation of the effect of trace metals on their growth revealed a striking beneficial effect of iron on each of eight organisms examined[4]. These results and the importance of iron in respiratory pigments suggested the likelihood that cytochromes were present.

Cultures were grown in 100 ml. yeast dextrose broth (yeast extract, 10 gm./l.; dextrose, 10 gm./l.; *p*H 7·5) in 250-ml. Erlenmeyer flasks and incubated on rotary shakers at 28° C. until heavy growth was evident. The time varied from two to seven days, depending on the strain. Cells were harvested by centrifugation and washed with 0·9 per cent saline.

One species, *Streptomyces fradiae* strain No. 3535, was also grown in *NZ* amine medium (2·5 per cent *NZ* amine – Sheffield Farms casein hydrolysate, 1·0 per cent meat extract, tap water, *p*H 7·0) to investigate the possible effect of a change in composition of medium on the type of cytochromes present.

Homogenates were prepared by a modification of a method used by Nielands[5] for the extraction of cytochrome *c* from *Ustilago sphaerogena*. Cells were suspended in distilled water to form a thick slurry and adjusted with sodium hydroxide to *p*H 10·5. They were then disrupted by sonic vibration for 10–12 min. in a 'Raytheon' sonic oscillator (9 kc./s.).

Table 1. Absorption Maxima in Difference Spectra of Streptomycete Cytochromes (wave-lengths in mμ)

Streptomycetes*	α-peaks		β-peaks		γ-peaks	
S. fradiae 3535	559		530		430	
S. fradiae 3535†	559		528		424	
S. fradiae 3554	559		528		424	
S. flavovlus 3319	560		530		428	
S. coelicolor 3030	560		530		425	
S. aureofaciens 3550A	558		529		424	
S. lavendulae 3555	558	550	530		422	
S. lavendulae 3440–14	562	552	530		432	
S. aureus 3484	562	550	530		422	
S. viridoflavus 3685	562	552	532	520	422	
S. flavus 3321	561	552	530		430	412
S. griseus 3475	563	550	530		432	412
S. griseus 3570	563	550	528		468 423	
S. sp. 3749	562	550	530		425	

* Strain numbers are those of the Institute of Microbiology, Rutgers University.

† These results are from cells grown in *NZ* amine broth, all others from cells grown in yeast dextrose broth.

In most cases it was possible to obtain a difference spectrum directly from the homogenate without centrifugation by reducing one sample with sodium hydrosulphite and comparing it to an unreduced standard. Spectra were obtained with Beckman Model *DU* or Model *B* spectrophotometers, or a Cary Model 14*M* recording spectrophotometer. In every case the alpha and beta peaks could be observed as bands with a hand spectroscope in the homogenates as well as in whole-cell suspensions.

The results of the survey are presented in Table 1. To increase the accuracy of the comparison, the values presented were all obtained on the Cary recording spectrophotometer. Three conclusions can be drawn. (1) Two groups of cytochromes are clearly represented. A *b* type is indicated by the 558–563 mμ alpha peak; a *c* type by the 550–552 mμ alpha peak. The gamma peaks of *b* and *c* types show up as distinct entities in only two species. (2) The cytochrome composition was essentially the same in the different strains of *S. fradiae*, *S. lavendulae* and *S. griseus*. The 468 mμ peak in *S. griseus*, strain 3570, is unidentified. (3) Cultivation of *S. fradiae* in two different media did not alter the cytochrome composition.

The results indicate that the cytochrome composition of Streptomycetes is similar to that of other micro-organisms in spite of the fact that cytochrome oxidase has not been observed in alkaline homogenates, neutral homogenates, or whole-cell suspensions. They do not permit any choice between the possibilities that the methods employed were not sensitive enough to detect low concentrations of cytochrome oxidase or that the Streptomycetes have some other means of linking the cytochromes with oxygen.

Although the composition of the cytochrome from *S. fradiae* remained the same in two different media, it is possible that different environmental changes might result in a change of cytochrome. For example, changes in the cytochromes have been reported as a result of variations in oxygen tension, metal composition of the media, or the passage of cells from a resting state to a growing state[1]. Even if changes can occur, the fact remains that, under the conditions described, *S. fradiae* was able to grow well in two different media without the presence of any apparent cytochrome *c* pigments. The other strains in which no *c* was detected also grew well.

That five strains have only *b* type cytochromes is of considerable interest since *b* cytochromes are autoxidizable and might conceivably react through a path to oxygen other than through *c* and a_3. The

b cytochrome of *S. fradiae* 3535 has been partially purified and characterized[6].

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Removal of Internally Deposited Radiocerium by the Use of Chelating Agents

In recent years, polyamino-acids, and ethylenediaminetetra-acetic acid in particular, have proved of substantial value as therapeutic agents in cases of poisoning by radioactive or stable metals. However, the compounds hitherto investigated are of very poor efficiency when treatment is delayed[1], and are unable to prevent the deposition of certain elements, such as cerium[2] or lanthanum[3], in the skeleton, even when administered in most favourable conditions. In view of these findings, experiments on several other chelating substances were performed in the hope of obtaining more effective agents.

Albino rats averaging 130 gm. were injected intravenously with tracer amounts of cerium-144/praseodymium-144. The chemicals to be tested were administered intravenously in series 1 and 2 simultaneously with the radiocerium and in series 3 by intraperitoneal route 3–5 min. after incorporation of radiocerium. The animals were killed after 48 hr., the organs processed and their cerium-144 content determined.

As shown in Table 1, the bulk of the agents tested proved to be either of low efficiency or ineffective with regard to the fixation of radiocerium by the skeleton. The administration of substances I, IV, VII caused even a higher retention significant at the 20, 1 and 5 per cent level respectively, in spite of the relatively high dosage. A substantial minimization of the skeletal deposition was achieved only by the two substances X and XI, possessing oxygen as heteroatoms, as well as by the condensed polyphosphate VIII, acting according to Thilo[4] as a soluble ion-exchanger. It should be mentioned that the polyphosphate is also effective, though only slightly, in removal of radiostrontium[5].

In series 4 the chelating agents were administered on the fifth, tenth and sixteenth day following the incorporation of radiocerium. The urinary excretion during this period occurs at an approximately constant level of 0·08–0·14 per cent per day. Urine and fæces were collected separately before and after administration of the agents, and their radioactivity assayed. The substances VII, VIII, III were ineffective, I, II, as well as zirconium citrate (450 mgm./kgm.), caused an increase of the urinary excretion

Table 1. Percentage of Cerium-144 Dose Administered and Mean Standard Error in the Relevant Organs
Each experimental group comprises 4–5 rats. The dosage (μmoles/rat) if not otherwise stated was 90 in series 1 and 2, 275 in series 3

Treatment	Skeleton	Liver	Kidneys
Series 1 (Wistar strain)			
Control (saline)	33·9±0·6	46·4±1·6	1·83±0·07
I Ca-Na_2-Ethylenediaminetetra-acetate	37·0±1·9	2·1±0·3	0·29±0·02
II Ca-Na_2-1,2 Diamino-*cyclo*hexane tetra-acetate*	32·0±0·4	5·5±0·6	0·41±0·06
III 8-Quinolinol-5-sulphonic acid	23·2±2·0	32·2±1·9	1·58±0·15
Series 2 (Freiburg strain)			
Control (saline)	25·2±1·2	60·0±2·1	1·30±0·15
IV Ca-Na_2-N-Hydroxyethylethylenediaminetriacetate†	35·4±2·2	2·2±0·1	0·24±0·01
V Na-N,N-di(α-hydroxyethyl)glycine†	28·5±2·0	20·3±1·4	1·85±0·05
VI 3 μ*M* *o*-Tolylbiguanide‡	21·3±0·8	45·2±1·6	1·25±0·12
VII Na-Trimetaphosphate§	33·4±3·4	30·4±4·4	1·72±0·19
VIII Ca-Graham's salt, 25 mgm.§	7·0±0·9	2·9±0·5	3·38±0·15
Series 3 (Freiburg strain)			
Control (saline)	27·9±2·1	51·4±2·9	2·37±0·22
II Ca-Na_2-1,2 Diamino-*cyclo*hexane tetra-acetate*	27·8±0·7	21·4±2·0	0·76±0·06
IX Ca-Na_2-N-(2-*cyclo*hexanol)-iminodiacetate*	30·6±1·0	15·9±0·5	0·68±0·05
X Ca-Na_2-Ethyleneglycol-*bis*-β-aminoethylether-N,N,N′,N′-tetra-acetate*	13·1±0·5	2·4±0·1	0·37±0·03
XI Ca-Na_2-β,β′-Diaminodiethylether-N,N,N′,N′-ditetra-acetate*	9·0±0·5	3·1±0·5	0·34±0·02

* By courtesy of J. R. Geigy S.A., Basle.
† By courtesy of the Dow Chemical Co., Midland, Mich.
‡ By courtesy of Monsanto Chemical Co., St. Louis, Miss.
§ By courtesy of Chemische Werke Albert, Wiesbaden-Biebrich.

by a factor of 2–3, substance IV by a factor of 6–7, and substance X by a factor of 10. The most striking effect was obtained for substance XI, which raised the urinary excretion from the base level up to as much as 4–5 per cent per day. The exceptionally high efficiency of diaminodiethylether tetra-acetic acid in early as well as in delayed treatment makes this substance seem worthy of more detailed investigation. Experiments now in progress will be reported later.

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Action of Blue Light on the Germination of Seeds

The mutually reversible influence of red and far-red radiation on seed germination is to-day a well-established fact. The role of other regions of the spectrum is less certain. Conflicting results, for example, have been reported on the action of blue light on germination (see review in ref. 2). In the present work we have investigated the effect of light in this part of the spectrum, and especially the change

of this effect with time elapsed since the start of imbibition. It is known that even for red light the sensitivity of the seeds changes with the time[3]. The seeds used were lettuce seeds var. Grand Rapids. The methods of imbibition, counting and irradiation were as in ref. 3. Spectral bands were isolated using the following filters:

Table 1

Filter	Light incident on seeds (ft.-candles)
(1) Corning glass No. 430 (3 mm.)	30
(2) Corning 5113 (3·35 mm.) + Corning 3389 (2·0 mm.)	1·7
(3) Chance's glass *OBR* (3 mm.) + *OGRI* (3 mm.)	10·5

The light transmission through these filters is shown in Fig. 1. Apart from a very slight (1 per cent) transmission at about 750 mμ by filter 1, this filter transmits a broad band between 350 and 590 mμ. Filter 2 transmits a very narrow band, with maximum at 430 mμ, the (asymmetrical) half-width being − 10 and + 25 mμ only. Filter 3 isolates a band between 450 and 590 mμ. These two filters show no perceptible transmission in the red or far-red region. Fig. 2 shows the results obtained. All three filters show identical behaviour in that only after about 10 hr. from imbibition do they exhibit a noticeable promoting effect on the percentage of germination. Filter 1 has a maximum effect after 13 hr., raising the percentage of germination by 46 per cent. This cannot be due to the small red or far-red component, since these lights, on the contrary, show decreased effects at these stages of the germination process. This is confirmed by the similar behaviour of filters 2 and 3. In particular, filter 2, which isolates a very narrow band of blue light, exhibits an inhibitory effect on germination during the first 6 hr., changing to a promoting effect only after 10 hr. The extent of this inhibition in comparison with that caused by the far-red component is shown in Table 2, which gives the percentage germination of seeds germinated: (1) in darkness; (2) illuminated 30 min. after imbibition with far-red; or (3) with filter 2 for 3 min.

Table 2

(1)	(2)	(3)
41 ± 4	28 ± 5·6	29 ± 2·2
33·5 ± 3·2	24·5 ± 5·8	25 ± 3·5

We find thus that the blue region of the spectrum, where certainly different absorption bands are responsible for the photo-response, nevertheless exhibits effects of promotion and inhibition of germination similar to that of red or far-red light.

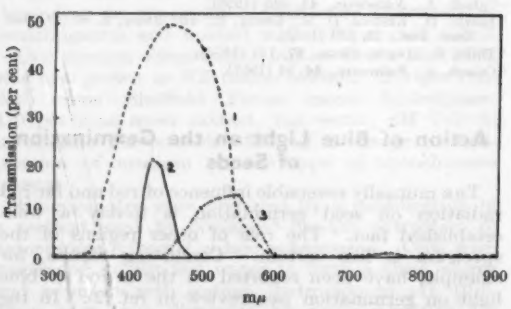

Fig. 1. Transmission of filters 1, 2 and 3 in the different spectral regions

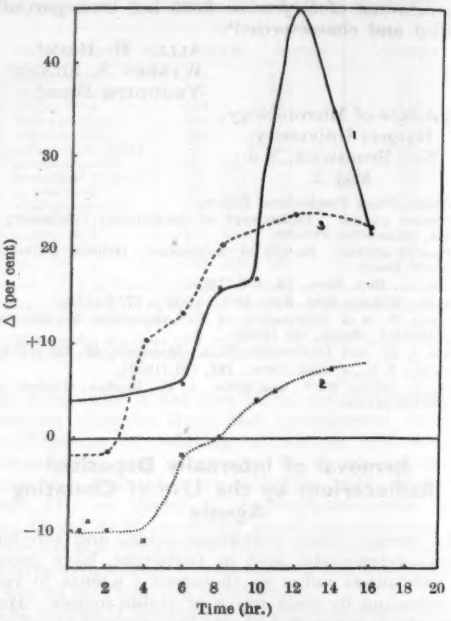

Fig. 2. Germination of lettuce seeds after illumination with filter 1 (1 min.), filter 2 (5 min.) and filter 3 (3 min.) at different times after the start of imbibition. The ordinate gives the difference between the percentage germination of the illuminated seeds and that of seeds kept in darkness. The zero line represents the percentage germination in darkness

However, the dependence on time of the photo-reaction for blue light is quite different from that for red or far-red illumination.

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Effect of Ultra-Violet Radiation on the Respiration-Rates of Tobacco Leaves, and its Reversal by Visible Light

Bawden and Kleczkowski[1] have shown that injury to the leaves of higher plants by exposure to ultra-violet light is prevented by subsequent exposure to visible light, and have related this effect to the phenomenon of 'photo-reactivation' or 'photo-reversal'. During an investigation of the effect of irradiation on the establishment of virus infection in tobacco leaves evidence of a similar effect on leaf respiration has been obtained, and further investigation produced the results presented below.

Tobacco leaves were exposed to ultra-violet radiation of a wave-length of 2537 A. at an intensity of 870 μW./cm.^{2} for 1–4 min.; they were then detached and placed in the dark and their respiration-rates measured for 10 hr. with an infra-red carbon

Table 1. THE EFFECT OF ULTRA-VIOLET ON THE RESPIRATION-RATES OF TOBACCO LEAVES

Means over 10 hr. in mgm. CO_2/hr./gm. dry matter

Exposure	Respiration	Ratio $\frac{\text{Irradiated}}{\text{Non-irradiated}}$
0	4·15	
1 min.	4·20	1·01
2 min.	4·28	1·03
3 min.	4·63	1·11
S.E.	± 0·257	
	No. of determinations represented by means = 8	
0	3·48	
4 min.	4·14	1·19
S.E.	± 0·206	
	No. of determinations represented by means = 10	

dioxide analyser. Table 1 shows that the respiration-rates increased with increasing exposure time, until, after 4 min. exposure, the rates were increased by 20 per cent above the respiration-rates of comparable non-irradiated leaves.

To test whether this effect was reversed by visible light, leaves were irradiated for 5 min., and then half of them were kept in the dark for 2 hr. while half were exposed to full sunlight in a glasshouse. A similar number of non-irradiated leaves were given the same treatments as controls. Respiration measurements were begun at the end of the 2-hr. period, each experimental run involving the comparison of the respiration-rates of four leaves from each of the four treatments, over the same 10 hours. Table 2 shows that the respiration-rates of leaves irradiated and then kept in the dark were again 20 per cent higher than rates for non-irradiated leaves also kept in the dark, but the rates for irradiated leaves exposed to sunlight were not significantly higher than those of non-irradiated leaves which had also been exposed to sunlight.

Table 2. THE EFFECT OF EXPOSURE TO VISIBLE LIGHT FOR 2 HR. ON THE RESPIRATION OF TOBACCO LEAVES AFTER IRRADIATION WITH ULTRA-VIOLET FOR 5 MIN.

Means over 10 hr. in mgm./CO_2/hr./gm. dry matter

	Treatment after irradiation	
	2 hr. in light	Kept in dark
Irradiated	3·39	3·71
Non-irradiated	3·18	3·06
S.E.	± 0·190	
Ratio $\frac{\text{Irradiated}}{\text{Non-irradiated}}$	1·07	1·21

No. of determinations represented by means = 10

Bawden and Kleczkowski suggest that changes in leaf-cell components caused by ultra-violet radiation are reversed by visible light, or that light stimulates synthetic mechanisms to produce new components to replace those damaged. The latter suggestion now seems unlikely, because increased respiration would be expected to accompany such increased metabolic activity and no increase in respiration-rate was observed. Ultra-violet radiation must initiate a process or processes which is capable of proceeding in the absence of ultra-violet, as the effect of the disturbance to cell metabolism is still detectable 10 hr. after irradiation, but darkness is necessary for the reaction to proceed.

Infection with tobacco mosaic virus increases the respiration-rates of tobacco leaves immediately after inoculation[2], and ultra-violet irradiation increases the respiration-rate immediately after treatment, the latter increase being four times the former. If both effects were due to action on the same cell component, the more rapid rates of change indicated by the larger energy expenditure after irradiation may mean that reduced supply of this component is responsible for the prevention of virus synthesis in irradiated leaves. The mechanism by which visible light counteracts this effect remains obscure.

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Rapid Estimation of the Areas of the Leaves of Crop Plants

FOR the physiological analysis of plant growth, estimates of the total leaf area per plant are required, and this may involve the determination of the areas of large numbers of leaves. Freeman and Bolas[1] have described a method for the construction of a measuring grid from which the areas of leaves may be read directly, providing that the leaf-shape approximates closely to an ellipse, as does the shape of the apple leaves used by them.

It has been found possible to modify this method for use on leaves which are not elliptical, and a satisfactory grid has been constructed for sugar beet leaves. Further modification is possible for any leaves for which there exists a convenient pair of dimensions linearly related to area, and in which the leaf shape is either independent of size or changes regularly with size. If the leaves are asymmetrical about the horizontal axis as in Fig. 1, two convenient measurements such as A and B which act as co-ordinates to some definable point on the leaf, such as P, the point of maximum width, are measured and the area of the leaf is measured with a planimeter. This is repeated for as many leaves as practicable over as wide a range of leaf-size as possible.

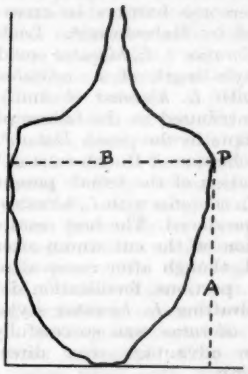

Fig. 1

For sugar-beet leaves, a linear regression of leaf area on AB accounted for 99 per cent of the variance of leaf area (regression coefficient $= b = 1{\cdot}05 \pm 0{\cdot}013$). The leaf area is therefore equal to b (AB). The co-ordinates of P are A, B, and the area represented by the point is AB units. Therefore, for P to indicate the leaf area in sq.cm. on a grid constructed in the manner described by Freeman and Bolas, the area of each square of the grid must be $1/b$ sq.cm. and the linear dimensions of the grid must be $\sqrt{1/b}$ cm. The grid constructed for sugar-beet leaves contained squares each of 0·97 cm. sides, so the figure at point P of each leaf placed on the grid represented the area of that leaf in sq.cm. To test the method the areas of 155 leaves were measured by the grid and by planimeter, the areas of the leaves varying from 1 to 400 sq.cm. Linear regression of the planimeter areas against the grid areas accounted for 99·2 per cent of the variance of the areas. This method is likely to be more accurate than the rating methods at present used when the leaf areas must be estimated without destroying the leaves.

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Successful Crossing in the Genus *Lathyrus* through Stylar Amputation

Interspecific hybridization in the genus *Lathyrus* has been attempted by several workers with little success. Barker[1] obtained viable, partially fertile hybrids from the cross *L. hirsutus* × *L. odoratus*. Taylor[2] claimed to have produced seeds by crossing *L. odoratus* with *L. pratensis* reciprocally. It has not been possible to repeat this cross. Senn[3] reported failure in 458 attempts at intercrossing seventeen species of *Lathyrus* and *Pisum sativum*. Marsden-Jones[4] successfully crossed *L. rotundifolius* with *L. tuberosus*. In this Department viable seeds have been produced from the following crosses: *L. cicera* × *L. sativus* (Saw Lwin*), *L. clymenum* × *L. ochrus* (Saw Lwin*), *L. clymenum* × *L. articulatus*—reciprocally (Davies), *L. articulatus* × *L. ochrus* (Davies), *L. hirsutus* × *L. odoratus* (McWhirter*), *L. odoratus* × *L. hirsutus* (Davies), *L. sylvestris* × *L. latifolius* (Ellis*).

The cross *L. hirsutus* × *L. odoratus* of Barker has been successfully repeated in this Department without difficulty. Some reciprocal crosses were attempted between 1951 and 1955 but were unsuccessful.

The reasons for failure in interspecific hybridization attempts have been discussed by Blakeslee[5], and methods employed to overcome barriers to crossability have been reviewed by Maheshwari[6]. Lack of success in the cross *L. odoratus* × *L. hirsutus* could be due to the greater style-length of *L. odoratus* (10 mm.) as compared with *L. hirsutus* (4 mm.). Style-length differences contributed to the failure of interspecific crossing attempts in the genus *Datura*[5].

A modification of the technique of Buchholz *et al.*[7] involving complete amputation of the female parent style was used in crossing *L. odoratus* with *L. hirsutus*, and several hybrids were produced. The best results were obtained by pollination on the cut stump after all the style was removed, though after removal of 4 mm., 6 mm. and 8 mm. portions, fertilization did sometimes take place. Grafting *L. hirsutus* styles on to the ovaries of *L. odoratus* was successfully effected, but showed no advantage over direct pollination on the cut stump.

For routine crossing and to avoid emasculation damage, a modification of Doak's soda-straw method[8] for crossing *Gossypium* was found to be useful. Pieces of the culms of various species of grass were fitted down over the styles of unopened flowers, excluding the anthers and with one end protruding from the keel. When the flower had opened pollen was pushed down the culm with a tightly fitting glass rod on to the stigmatic surface. This method may have wide application in work with other genera.

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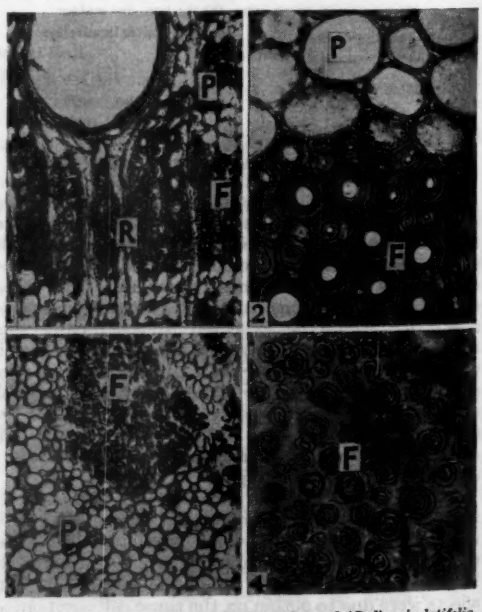
Difference in the Behaviour of Tissues in Ancient Plant Remains and during Chemical Treatment

Although considerable work has been done on the cell wall structures of ancient and buried woods[1] and their degradation[2] from chemical, physical and botanical aspects[3], little attention has so far been paid to the differential behaviour of the main tissues of such woods. While studying the minute anatomy of fossil woods and buried woods, we noted the peculiar behaviour of the two important tissues of the dicotyledonous woods. During long submersion of wood in water or soil, parenchyma cells and rays are usually found to retain their original structure better than the fibres (Fig. 1). This was reported by two of us (K. A. C. and S. S. G.), but no definite reason for such behaviour could be put forward except the nature of pits on the walls of fibres, vertical parenchyma cells and wood rays[4]. The main obstacle to chemical investigation has so far been the difficulty of obtaining pure samples of parenchyma and fibres from fresh woods. Recently, while working on bamboo, it has been possible to separate mechanically its parenchymatous and prosenchymatous tissues. This led us to think that it might be worth while analysing chemically these pure tissues and at the same time examining them microscopically at different stages of delignification, with the view of getting a clearer picture of the nature of the cell wall.

Chips of bamboo (*Dendrocalamus strictus* Nees) were delignified in a pressure autoclave by the conventional sulphate method for various periods. In this method, delignification was carried out with a solution containing sodium hydroxide and sodium sulphide in the ratio of 2 : 1 for various periods up



All are transverse sections. (1) Buried wood (*Dalbergia latifolia* Roxb.) of thousand years (× 120). (2–4) *Dendrocalamus strictus* Nees. (2) Untreated fibres and parenchyma (× 300). (3) After 5 hr. treatment (× 45). (4) Fibres of (3) highly magnified (× 300); cf. (2) and (4) and note difference in the structure of fibre wall. *F*, fibres; *P*, parenchyma; *R*, rays

Table 1. Analysis of Two Tissues in Bamboo and in the Unbleached Pulp at Different Periods of Delignification and their Lignin Content

Period of delignification including 1 hr. to bring to 162° C. (hr.)	Yield on bamboo		Lignin content	
	Fibre (per cent)	Parenchyma (per cent)	Fibre (per cent)	Parenchyma (per cent)
Raw chips	64·3	35·7	28·8	27·4
1·0	37·6	17·9	8·3	11·6
2·0	32·2	17·3	4·5	7·2
3·0	33·1	15·8	3·6	6·4
4·0	33·4	14·2	2·9	5·9
5·0	33·6	14·1	2·8	5·5
6·0	32·4	14·6	2·5	5·6

to a total of 6 hr., including 1 hr. taken to raise the contents to 162° C., the maximum temperature of delignification. The material (chips) to liquor ratio was 1 : 5. After each reaction the delignified chips were carefully and repeatedly washed with distilled water by diffusion, so that the anatomical structure was not disturbed. A sample of cooked chips was then taken out, properly embedded and cross-sections cut with a microtome. The rest of the delignified chips were macerated into separate tissue entities by mechanical disintegration. From a very dilute (0·1–0·05 per cent) slurry of this pulp in water, the fibre and parenchyma tissues were separated by hand-sieving successively on screens of 20, 120 and 200 mesh. The fibres were largely retained on 20 and 120 mesh. The fine parenchyma cells passed out finally through the 200 mesh. The tissue samples were checked under the microscope for purity and if found impure were re-screened. The separated tissues in their unbleached state were analysed for lignin. Fibres and parenchyma tissues in the original bamboo chips (untreated) were also estimated and their lignin content determined.

The results given in Table 1 show that the two tissues (Fig. 2) behave differently to delignification, the fibres reacting faster than the parenchyma cells. After 6 hr., the lignin in fibres is reduced to 2·5 per cent, whereas in parenchyma cells it is 5·6 per cent. The anatomical structure of these tissues after treatment for 5 hr. reveals that the parenchyma cells are still intact and adhere to each other (Fig. 3), while the fibres have undergone considerable disorganization and are individually separate from each other (Fig. 4). Thus it will be seen that there is a difference in the ability of these two tissues to resist delignification. This may to some extent explain why the fibres disorganize and disintegrate more quickly than the parenchyma cells in fossil and buried woods.

It is possible that work on the physical structure of these cells may also throw some light on this problem; this aspect we intend to take up.

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Germination of Oospores of *Pythium mamillatum* in Response to Exudates from Living Seedlings

The exudation of chemical substances from roots of higher plants, and the effect of these substances in increasing general microbial activity in the immediate vicinity of roots growing in soil (that is, the rhizosphere effect), have now been fairly well established. Nevertheless, the possible function of these exudates in the etiology of root disease, bringing about the germination of spores or propagules of root-infecting fungi resting in the soil, has received less attention than it undoubtedly merits. The recent interest shown in this subject[1,2] has prompted me to make a preliminary report of some similar studies now in progress with oospores of *Pythium mamillatum* Meurs.

Glass-fibre tape[3], 1·5 cm. in width, was divided down the middle, and cut into pieces approximately 5 cm. in length. After sterilization, these sections were placed on oat agar plates which were inoculated with *P. mamillatum*, and incubated at 25° C. for one month. At this stage, sufficient mature oospores had been formed in the interstices of the tapes for the purposes of the experiment, and few hyphæ remained. Microscopic observation of oospores on this material was facilitated by staining in phenolic rose bengal[4] for 1 min.

Tapes stained and examined after being buried for 3 days beneath 2–5-day old turnip seedlings in garden soil consistently showed that oospore germination had occurred. Oospores on tapes placed in similar soil in the absence of seedlings did not germinate. Only scattered areas on each tape were affected, suggesting that stimulation took place in close proximity to the roots themselves, a finding similar to that of Jackson[1]. Dreschler[5] has reported the production of zoospores directly from oospores of *P. mamillatum*, but during this investigation, germinating oospores invariably produced germ tubes.

Attempts to repeat the stimulation in culture have been successful. Oospores on tapes placed in Petri dishes filled with distilled water either failed to germinate at all or else germinated at such a low frequency that it was almost unmeasurable. On the other hand, when turnip seeds were sown in this water and allowed to develop in a normal manner, a striking increase in the frequency of oospore germination was observed even after two days. The stimulation occurred also when direct contact between oospores and seedlings was prevented by a layer of filter paper. Exudates from turnip seedlings have been collected and tested for stimulatory activity. Seeds were surface sterilized, and allowed to germinate and grow in sterilized distilled water for seven days. This water was then concentrated by freeze drying to a final volume one-tenth of the original. Application of this solution to oospores on glass-fibre tapes resulted in a marked increase in germination as compared with distilled-water controls.

The evidence suggests, therefore, that certain water-soluble stimulatory substances are liberated from living turnip seedlings, and have an activating effect on oospores of *P. mamillatum*. The nature of this stimulation remains to be elucidated, but Brown[6] has pointed out that such phenomena may involve a vitamin or phytohormone, or may, more simply, be a direct nutrient effect. The presence of chemical substances pertaining to both these cate-

gories has already been reported in root exudates. West[7] found biotin and thiamin in exudates from flax roots, and Fries and Forsman[8] detected several nucleic acid derivatives in pea root exudate. The latter group of compounds might well play a considerable part in stimulating resting bodies such as oospores in which both meiotic and mitotic nuclear divisions generally precede, or coincide with, germination. On the other hand, Rovira[9] has shown that fructose and glucose are exuded by pea and oat roots, and there are several reports of amino-acid material in root exudate. Both amino-acids and sugars, either singly or in conjunction, could sufficiently increase the nutrient level in the immediate vicinity of roots to cause germination of resting spores. Moreover, this latter effect, if operative, might apply more particularly to unspecialized parasites with a wide host range; more specific relationships between host root and resting spore might be expected in the case of specialized root-infecting fungi.

My thanks are due to Prof. C. W. Wardlaw for supervising this work, and to Dr. D. Park for much helpful criticism. Dr. P. F. Wareing placed certain facilities at my disposal.

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Expression of Sex in Flowering Plants

In a recent important review of the literature, Heslop-Harrison[1] has listed external variables which may modify sex-expression in flowering plants. The effects of variations in mineral nutrition, in the light regime and in temperature, of mutilation, grafting and the application of chemicals and hormones on the differential production of pistillate and staminate flowers are described. To this review should be added a body of literature on the effects of parasites which, by affecting differently the development of the gynoecium and the androecium, may influence the ultimate 'sex' of the flower. A curious case occurs in the grass *Glyceria maxima* (Hartm.) Holmb., where a late infection of the inflorescence by the smut fungus *Ustilago longissima* (Sow.) Mayen may transform the ovary into a leafy shoot while the stamens are little affected[2].

The greater part of this literature, however, deals with dioecious species of *Melandrium*, which have furnished the test material for so many other studies of sex-inheritance and expression. Both 'sexes' in these species produce androecial and gynoecial primordia; but usually only one of these develops to maturity. It has long been known that the staminal rudiments of a pistillate plant of *Melandrium* may be caused to develop (while the ovary aborts) as a result of infection by *Ustilago violacea* (Pers.) Fuckel. This change, which is probably the result of hormone production or destruction by the fungus[3], provides information which is not incompatible with the hypothesis developed by Heslop-Harrison[1] that the control of sex-expression depends basically upon local concentrations of auxin. Thus pistillate plants which are not systemically infected develop smutted staminate flowers where the fungus is present but produce unaltered pistillate flowers in parts of the plant which are free from infection[4]. Sometimes, lightly infected parts of a pistillate inflorescence will produce flowers in which, although the stamens are forced into development, the ovary is only reduced in size and still contains fairly well-developed ovules.

Observations and experiments on *Melandrium* and on the nature and effects of infection by *Ustilago violacea* have been reported in many papers by Schopfer and Blumer[5–13] and by me[4,14,15]. I was able to show that sex-linked characters in *Melandrium* may be distinguished from secondary sexual characters by their behaviour following the infection of a pistillate plant[14]. The latter quantitative characters tend to be replaced by their counterparts of a staminate flower, whereas the former, which are unaffected, are usually qualitative (and therefore scarcely likely to be determined by simple hormonal means).

Most important is the ability of the single factor of infection to cause *both* the abortion of the gynoecium and the development of the androecium in a pistillate plant. As I pointed out[14], this argues against there being a qualitative difference between 'female-suppressors' and 'male-promoters' such as have been postulated by Westergaard[16–18] to occupy the differential segment of the *Y*-chromosome in *M. album* (although whether anthers or ovules are fertile when produced probably depends upon other factors in addition). If, as Heslop-Harrison suggests, pistil-development depends upon a high auxin-level and stamen-development occurs when it is lower, both 'female-suppressors' and 'male-promoters' may prove to be inhibitors of auxin production or action.

No work has yet been done on the auxin-levels of infected and uninfected pistillate and staminate plants or parts of plants of *Melandrium*, although this might provide valuable evidence for the evaluation of this hypothesis. As the same fungus exerts a similar aborting effect on the gynoecium in hermaphrodite genera of the Caryophyllaceae while *Ustilago succisae* Magnus has the same action in *Succisa pratensis* Moench, further informative auxin-assays are possible.

Only Werth[19] has reported a feminizing influence of the fungus when a staminate plant of *Melandrium* is infected (except for an early slip by Plowright[20] which was corrected soon after[21]). Probably Werth's material consisted of a 'spontaneous' genetically determined hermaphrodite such as are known to arise occasionally in the dioecious species of this genus[15]. Nevertheless, Schopfer[12] has claimed that the infection of staminate plants may increase the rate at which hermaphrodite flowers are formed on male stocks (although this was surprisingly rapid even in his controls). However, his plants were hybrids between *M. rubrum* (Weig.) Garcke and *M. album* (Mill.) Garcke in which it has been shown[15] that there is a lack of complete balance between the sex-determining genes contributed by each of the parents, resulting in a tendency towards hermaphroditism.

There are at least sixteen families of flowering plants where functionally pistillate flowers are known

to occur in species which are usually hermaphrodite. Whether they occur in a gynodioecious or gynomonoecious manner, these pistillate flowers are regularly smaller than the hermaphrodite ones[21]. By contrast, where androdioecism or andromonoecism occurs, the staminate flowers are generally as large as hermaphrodites. In at least six families which show what appears to be evolutionarily recent dioecism, there is a similar contrast between pistillate and staminate flower-sizes. This suggests that, although the separation of the sexes has undoubtedly evolved many times in the phylogeny of the flowering plants, the hormonal control of sex-expression is likely to be a relatively simple and general one and may well be connected with the level of auxin-activity in the developing flower-bud. In at least some gynodioecious members of the Labiatae, the abortion of the anthers is associated with a dwarfing of the plant in all its aerial parts.

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Mast Cells in the Epithelium of the Œsophagus

Mast cells in epithelium are considered to be extremely rare, and those who have noted them in this site consider that they have migrated from other tissues[1]. During a study of the structure of the mucous membrane of the œsophagus in the adult cat, we have been impressed by the constant finding of large numbers of mast cells in the epithelium. Basic lead acetate was used as a tissue fixative and metachromasia was demonstrated by staining with azure *A* or with toluidine blue. The mast cells are situated in the basal layers of the epithelium (Fig. 1), and were never observed in the more superficial regions. Although comparative counts have not yet been carried out, it appeared that the epithelium of the cranial two-thirds of the œsophagus contained fewer mast cells than the caudal third where, in any high-power field, as many as seven cells might be found. From the present work, in which the œsophagi of thirty animals have been examined, no evidence can be put forward to suggest that these mast cells appear in the epithelium as the result of migration

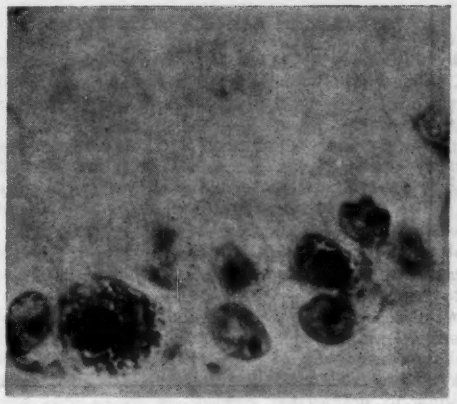

Fig. 1. Two mast cells in the basal epithelial layer of the œsophagus. (× 1,340)

from the subepithelial tissues, or that they migrate within the epithelium itself.

During the study of wound healing in the mucous membrane of the œsophagus[2], mast cells were not found among the regenerating epithelial cells until after epithelialization had become complete.

The significance of these findings, and of other work now in progress on the distribution of mast cells in different animals of varying ages, will be discussed fully elsewhere.

F. R. Johnson
R. M. H. McMinn

Department of Anatomy,
University of Sheffield.

May 16.

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Latent Infection of Rabbits by Adenovirus Type 5

Adenoviruses were first isolated by Rowe, Huebner, Gilmore, Parrott and Ward[1] from cultures of human adenoids undergoing spontaneous degeneration. The same group of workers[2] observed that these agents can be isolated from a large proportion of adenoids and tonsils after these tissues are grown *in vitro* for a certain time. Attempts to isolate the virus by direct inoculation of tissue homogenates into cultures of susceptible cells usually resulted in failure which was attributed to the presence of virus-neutralizing antibody demonstrated in these tissue homogenates. The process of 'unmasking' of the virus in tissue cultures would be a consequence of dilutions of this antibody as a result of successive fluid changes during tissue cultivation. Similar phenomena have been reported in the study of poliomyelitis[3,4], salivary gland virus[5], influenza[6], psittacosis[7] and typhus rickettsiæ[8], and different mechanisms have been suggested to explain virus unmasking.

By the use of tissue cultures we have been able to demonstrate the persistence of adenovirus type 5 in the spleen of adult rabbits for periods up to 8 weeks after inoculation. In a representative experiment, six rabbits were inoculated intravenously with $10^{9.2}$ 50 per cent tissue culture doses of the prototype strain of adenovirus type 5. The animals were bled at intervals for measurement of antibody pro-

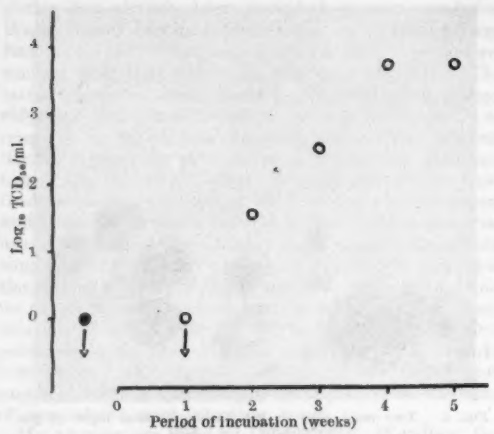

Fig. 1. Virus infectivity levels in spleen homogenate, ●, and in successive fluids obtained from spleen cultures of the rabbit, killed 20 days after inoculation

duction. No clinical signs of disease were observed in any of the rabbits throughout the period of observation. Individual rabbits were killed 3, 6, 13, 20, 27, 41 and 55 days after inoculation and the spleens were removed. Part of the tissue was minced and maintained in Maitland-type cultures with approximately twenty tissue fragments of about 1 mm.³ in 2 ml. of a fluid medium consisting of 5 per cent normal horse serum in bovine amniotic fluid. These cultures were set up in universal containers stoppered with rubber bungs and incubated at 37° C. for six weeks with weekly changes of fluid. The remaining spleen tissue was suspended in nine times its volume of broth-saline, crushed in a Ten Broeck tissue crusher, centrifuged and the supernatant of this 10 per cent spleen suspension was preserved. Tissue-culture fluids and spleen suspensions were stored at − 10° C. and tested in HeLa cells for presence of adenovirus. Materials giving rise to cytopathic effect were titrated in HeLa cell cultures and the end-points were based on cytopathic effect observed after incubation for twenty-seven days. The viruses isolated were identified by the serum neutralization test. Negative materials were tested in at least twelve cultures of HeLa cells, each inoculated with 0·1 ml. of undiluted material and observed for twenty-seven days. Blind passages of negative HeLa cell cultures were performed on several occasions and gave uniformly negative results.

Complement-fixing and neutralizing antibodies could not be demonstrated in any of the rabbit sera collected three days after inoculation; but in all animals kept beyond this period both these antibodies were detected at six days and usually reached maximum levels at 13–20 days after inoculation. The antibody titres reached at this time were maintained throughout the period of observation.

Inoculation of the spleen homogenates into HeLa cell cultures revealed the presence of adenovirus type 5 at a concentration of $10^{4.6}$ 50 per cent tissue-culture doses in the spleen suspension from the rabbit killed three days after inoculation. All the remaining spleen suspensions gave negative results when similarly tested. The same virus was, however, recovered from each of the spleen tissue cultures after varying periods of incubation. Fig. 1 shows the virus infectivity titres reached in successive fluids obtained from spleen cultures of the rabbit killed twenty days after inoculation. This result is representative of the series under study, but the time at which virus could first be detected in culture fluids was variable and tended to be prolonged with increasing intervals after the rabbits were inoculated. Some of the rabbit spleens under study were cultivated in plasma clot roller tubes or in cellular sheets obtained by trypsin treatment. The outgrowth observed in these cultures consisted mainly of fibroblast-like cells, and no signs of cytopathic effect could be observed in cultures shown by tests in HeLa cells to be supporting virus multiplication. It has, however, been observed that inoculation of large doses of adenoviruses into such cultures gives rise to a cytotoxic effect not associated with virus multiplication.

The present findings demonstrate the persistence of adenovirus type 5 in rabbit spleens for at least two months following inoculation. This has been the longest period tested so far. A few other experiments with the same virus type gave essentially identical results, but limited attempts to repeat this observation with adenovirus types 1, 2, 3 and 4 were not successful.

The similarity between our findings and those reported by Rowe *et al.*[1,2] with human adenoids and tonsils suggests that the present system may represent a useful experimental model for studies on latency and unmasking of adenoviruses. Attempts to elucidate the mechanism of unmasking are in progress and preliminary results are in agreement with the suggestion put forward by Rowe *et al.*[2] that the presence of neutralizing antibody in tissue suspensions may explain at least in part the failure to demonstrate virus in these materials.

We are indebted to Dr. C. H. Andrewes for his interest and constant encouragement in the course of this work.

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Introduction of a Grapsoid Crab, *Brachynotus sexdentatus* (Risso), into British Waters

The grapsoid crab, *Brachynotus sexdentatus* (Risso) subsp. *gemmellaroi* (Rizza), has been found to be common in the Queen's Dock, Swansea. The crab is a Mediterranean form[1], which does not seem to have been recorded previously in Britain. Indeed it appears that this is the first record of *Brachynotus sexdentatus* north of the Mediterranean. Specimens have been compared with material in the British Museum (Natural History) and their identification has been kindly confirmed by Dr. Isabella Gordon.

Queen's Dock is artificially warmed by sea water which passes through a nearby electrical power station, and the crab lives together with *Carcinus maenas* Leach among stones which are encrusted with such organisms as *Balanus amphitrite* Darwin, *Hydroides norvegica* (Gunnerus) and *Mercierella enigmatica* Fauvel. Shipping using the Dock consists mainly of oil tankers, some of which load in the eastern Mediterranean, and it seems likely that the crab has been transported by these vessels.

Wolff[2] records several examples of the transportation of crabs by ships, and those introduced to north-western European waters are *Planes minutus* Leach, *Eriocheir sinensis* Milne-Edwards, *Pachygrapsus transversus* Gibbes, *Callinectes sepidus* Rathburn and *Rhithropanopeus harrisi* Gould. Of these, *Eriocheir sinensis* has become established in several estuaries on the Continent[3,4], and *Rhithropanopeus harrisi* became established in the Zuider Zee (at least since 1876)[5] and in the South Harbour at Copenhagen[2].

Examination of ships in dry dock suggests that hull fouling itself would be an unsuitable habitat for the transport of crabs, unless a vessel had been in harbour for a considerable length of time. *Planes minutus* may cling to fouling algae, but the species is often found among floating weed[4], and it may occasionally reach the west coasts of Britain from North America among floating weed or timber[6]. In addition, occasional records of the American blue crab, *Callinectes sepidus*, in European waters may be accounted for in this way, or it may be transported in the ballast tanks of ships[3]. *Eriocheir sinensis* was probably carried in ballast tanks[3] and *Rhithropanopeus harrisi* may have been carried in the same manner[2]. *Pachygrapsus transversus* was found among external hull-fouling on a wooden ship in the harbour at Copenhagen, but the vessel had previously been docked for some time at Bermuda[7].

Brachynotus sexdentatus normally hides in crevices between stones, and it may be transported by sheltering beneath the grids which cover the sea inlet valves to the oil-storage tanks of tankers. Normal fouling seems inadequate to provide a foothold for *Brachynotus*, and shipping enters the Dock fully loaded and not in ballast. The lowest temperature recorded in the Dock during the winter of 1956–57 was about 14° C. and salinity values never went below 30‰, so it appears that the crab could tolerate at least a summer voyage from the Mediterranean to British waters.

I am indebted to Mr. W. A. Morris, dock manager, for permission to carry out a faunistic survey of Swansea Docks and to Prof. E. W. Knight-Jones for much assistance. It is hoped to publish elsewhere descriptive notes on the specimens.

E. NAYLOR

Department of Zoology,
University College,
Swansea.
May 6.

[1] Monod, Th., *Mem. Inst. Franç. d'Afrique Noire*, **45** (Dakar, 1956).
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Production of Carbon in the Sea

THE oxygen equivalent of the daily production of carbon in the North Sea, reported by D. H. Cushing[1], ranges from 0·010 to 0·050 milligrams of oxygen per litre. These quantities, which could influence the saturation of a likely sea water to the extent of about 0·012–0·06 per cent, are much less than the 8–10 per cent supersaturation reported in different seas at the time of photosynthetic activity.

A plant growing in air can be enclosed for the study of photosynthesis without stimulating a bacterial flora which the enclosure of plants growing in a sea water always seems to do, with the risk of competition for a limited supply of nutrients. Under quiet sunny conditions, the inshore waters of the English Channel can become 50 per cent supersaturated with oxygen, as they did on several days in July 1955, with an oxygen production of some 1·7 mgm. per litre, equivalent to a round 650 mgm. of carbon per cubic metre on the scale used by Cushing. On April 13, 1957, at 8.45 hr., the sea was found to be 104 per cent saturated with oxygen. During the next seven hours, the oxygen content in the ambient sea rose by 1·79 mgm. per litre. Between 11.15 hr. and 13.20 hr., the oxygen rose by 0·94 mgm. per litre.

The carbon-14 technique for following the absorption of carbon dioxide is far more sensitive and elegant than the chemical estimation of oxygen, but it is suggested that some oxygen estimations should be made on the more active parts of the bulks of sea water from which the samples are taken for enclosure, in order to provide some certainty that the results are not only those of a laboratory exercise.

J. H. OLIVER

The Laboratory,
Hayling Ferry,
Hayling Island,
Hants.
May 1.

[1] Cushing, D. H., *Nature*, **179**, 876 (1957).

THE measurement of oxygen production for a short period using black and clear bottles to separate respiration from photosynthesis[1] yields results in eutrophic waters similar to those using the carbon-14 technique, provided that the experiments do not last longer than 24 hr.[2]. My experiments lasted three hours, during which time bacterial effects will be small.

My results are similar to those of Steemann Nielsen off the mouth of the English Channel[3] and are of the order expected from the yearly production of about 80 gm. carbon/m.[2] from changes in phosphorus, nitrogen and carbon dioxide[4]. Dr. Oliver's observation of 10–20 gm. carbon/m.[3] in seven hours in inshore waters is of considerable interest.

D. H. CUSHING

Fisheries Laboratory,
Lowestoft.

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FORTHCOMING EVENTS

Tuesday, September 24

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Society of Chartered Accountants, 46 Fountain Street, Piccadilly, Manchester 2), at 6.45 p.m.—Miss Anne Shaw: "Training and Opportunities for Women in Engineering".

Tuesday, September 24—Thursday, September 26

SOCIETY OF CHEMICAL INDUSTRY (in the William Beveridge Hall, Senate House, University of London, W.C.1)—Conference on "Industrial Carbon and Graphite".

Wednesday, September 25—Thursday, September 26

IRON AND STEEL INSTITUTE, IRON AND STEEL ENGINEERS GROUP (at Church House, Westminster, London, S.W.1)—Meeting on "Air Pollution in the Iron and Steel Industry".

Thursday, September 26

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department, Imperial College, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. J. W. F. Bell: "Sound Propagation in Solids".

Friday, September 27—Saturday, September 28

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Brunel College of Technology, Acton, London, W.3).—Conference on "Transistors".

Saturday, September 28

ASSOCIATION OF CLINICAL BIOCHEMISTS (joint meeting with the ASSOCIATION OF CLINICAL PATHOLOGISTS, at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 9.30 a.m.—Scientific Meeting. 5 p.m.—Annual General Meeting.

BRITISH INTERPLANETARY SOCIETY (at Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Prof. S. F. Singer: "Geophysical Research with Artificial Earth Satellites".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

FORESTRY OFFICER (with a degree in forestry from a British university, and practical experience in forestry work) IN THE PLANNING DEPARTMENT, Durham County Council, for work on schemes for the planting of derelict pit heaps, tree preservation orders, felling licences, park layouts, etc.—County Planning Officer, 10 Church Street, Durham (September 26).

LECTURER IN STATISTICS—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (September 27).

CIBA FELLOW (with an honours B.Sc. or equivalent, and preferably some knowledge of physiology) IN BIOCHEMISTRY in the Department of Surgery, to work as a member of a team investigating endocrinological problems related to surgery—The Secretary, Queen's University, Belfast (September 28).

LABORATORY TECHNICIAN for physics, chemistry and biology laboratories—The Secretary, Paddington Technical College, Saltram Crescent, London, W.9 (September 28).

LECTURERS (2) IN THE DEPARTMENT OF PATHOLOGY—The Secretary, The University, Edinburgh (September 28).

ASSISTANT LECTURER (with good qualifications and teaching experience in geography) IN EDUCATION—The Registrar, University College of North Staffordshire, Keele, Staffs (September 30).

LECTURER; and a RESEARCH ASSISTANT (Academic) IN THE INSTRUMENT TECHNOLOGY SECTION, Physics Department, R.C.S.—The Professor of Instrument Technology, Physics Department, Imperial College, London, S.W.7 (September 30).

LECTURER IN EXPERIMENTAL AERODYNAMICS—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks (September 30).

PROFESSOR OF APPLIED MATHEMATICS—The Registrar, University Office, 46 North Bailey, Durham (September 30).

RESEARCH ASSISTANT (with a first- or second-class honours degree in chemistry with an ancillary biological subject, or chemistry with physiology in the final year of the honours degree) IN BIOCHEMISTRY in the Department of Physiology and Pharmacology—The Clerk to the Governors, Chelsea Polytechnic, London, S.W.3 (September 30).

STAFF TUTOR (with good qualifications in any branch of the physical sciences) IN PHYSICAL SCIENCE—The Director of Extra-Mural Studies, The University, Edmund Street, Birmingham 3 (September 30).

LECTURER (Grade I or II) IN LOW TEMPERATURE PHYSICS—The Registrar, The University, Bristol (October 1).

LECTURER IN ELECTRICAL ENGINEERING; a SENIOR LECTURER (with industrial and/or research experience, and capable of initiating and supervising work of research assistants) to teach electronics and physics to B.Sc. general and special degree level; and a LECTURER to teach physics to B.Sc. general and special degree level—The Registrar, College of Technology, Birmingham (October 2).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Sheffield (October 5).

STATISTICIAN (Scientific Officer) (with an honours degree in mathematics, either including statistics or with a postgraduate diploma in statistics, and preferably experience in applying statistics to biological problems) for the design and analysis of experiments—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (October 5).

LECTURER OR ASSISTANT LECTURER IN PSYCHOLOGY—The Registrar, The University, Hull (October 7).

LECTURERS (2) IN GEOGRAPHY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 12).

MEDICAL ENTOMOLOGIST (with at least a second-class honours B.Sc. degree with entomology or zoology as major subjects, or a higher academic qualification) with the Government of the Federation of Rhodesia and Nyasaland—The Secretary (R), Rhodesia House, 429 Strand, London, W.C.2 (October 12).

ZOOLOGIST (with an honours degree, and preferably with some experience of research in marine biology) at the Scottish Marine Biological Association's Edinburgh Laboratory, to join a team studying plankton in relation to the herring—The Officer-in-Charge, Oceanographic Laboratory, 78 Craighall Road, Edinburgh 6 (October 15).

ANALYST (with a B.Sc. degree, preferably with honours in organic chemistry or equivalent, and an interest in biochemistry and animal nutrition research) IN THE NUTRITION RESEARCH LABORATORY, Department of Agriculture, Glenfield, New South Wales, Australia, for duties which include the supervision and testing of analytical procedures in biological chemistry (Vitamin A blood ketone assays, etc.) involving techniques such as paper chromatography and spectrophotometry—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (October 18).

PROFESSOR OF HORTICULTURE—The Registrar (Room 9 O.R.B.), The University, Reading (October 18).

LECTURER/SENIOR LECTURER IN VETERINARY PATHOLOGY AND BACTERIOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 19).

NUFFIELD FELLOW IN EXTRACTION METALLURGY—Prof. F. D. Richardson, Imperial College, London, S.W.7 (October 30).

KEEPER OF THE OTAGO MUSEUM AND LECTURER IN ANTHROPOLOGY at the University of Otago, Dunedin, New Zealand (joint appointment)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 31).

LECTURER IN FOREST MANAGEMENT at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

LECTURER IN MATHEMATICS at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (October 31).

LECTURER OR SENIOR LECTURER IN BOTANY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

SENIOR LECTURER and a LECTURER IN THE DEPARTMENT OF PHYSICS, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, November 1).

METALLURGIST, Basic grade (with A.I.M. or exempting qualifications, and appropriate experience including process working of metals) to assist in the management of a team engaged in the production of components in radioactive metals and to take part in the development of process techniques—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. B/1336/34.

PHYSICAL CHEMIST in the Pneumoconiosis Unit of the South African Institute for Medical Research, Johannesburg, to work on the physical chemistry of proteins and other large molecules encountered in silicosis and related lung diseases—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2.

QUALIFIED TECHNICIAN (male or female) IN THE PATHOLOGICAL LABORATORY—The Secretary, Wembley Hospital, Wembley, Middlesex.

REGIONAL TRIALS OFFICER, to work at the County Institute of Agriculture, Winmarleigh Hall, Lancs.; and an ASSISTANT TRIALS OFFICER, to work at Leeds University Farm, Headley Hall, Yorks—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

RESEARCH ASSISTANT (with a science degree) IN THE DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY, to assist with research on the biological action of copper—The Physiology and Biochemistry Department, The University, Southampton.

SOLID STATE PHYSICIST OR CHEMIST (preferably with radiation experience) at a National Laboratory, to assume responsibility for the direction of studies concerned with effects of nuclear radiation on semi-conductor materials—American Nuclear Science Corporation, 61 Broadway, New York 6, N.Y., U.S.A.

TECHNICAL ASSISTANTS (2) (women, with experience of hand computing and of programming for electronic computers) in the University of London Computation Unit, which will be equipped with a Ferranti Mark II mercury computer—The Secretary to the Senate, University of London, Senate House, W.C.1.

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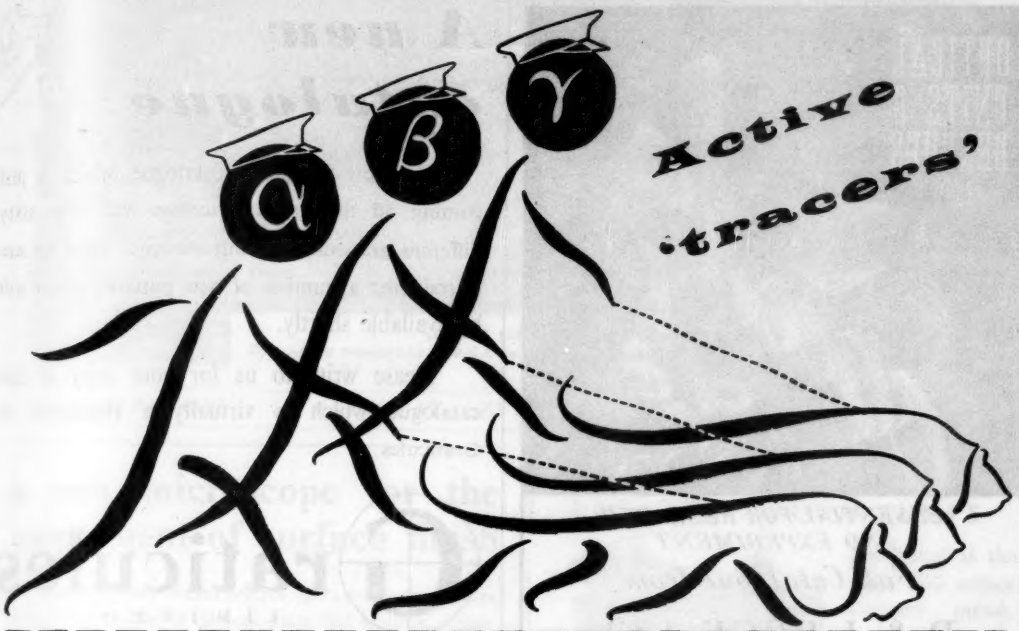

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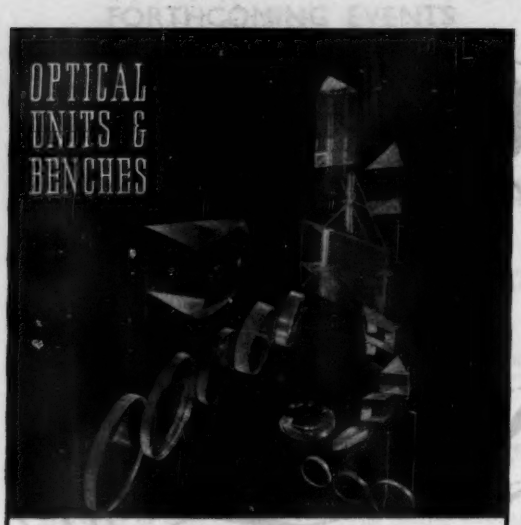

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